Issued June 28, 1913.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—BULLETIN NO. 96.
MILTON WHITNEY, CHIEF.

SOILS OF THE UNITED STATES.

(EDITION, 1913.)

BY

CURTIS F. MARBUT, HUGH H. BENNETT, J. E. LAPHAM, AND M. H. LAPHAM.

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BUREAU OF SOILS.

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SOIL SURVEY.

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M. H. Lapham, Inspector, Western Division.
J. W. McKericher, *Secretary.*

LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Bureau of Soils,
Washington, D. C., November 8, 1912.

Sir: In 1903 a small handbook entitled "Instructions to Field Parties and Descriptions of Soil Types" was issued as a guide to the soil-survey field parties. This was revised and brought up to date in 1904 and again in 1906, the name being changed to Soil Survey Field Book. In 1909 the volume of work had outgrown the dimensions of a pocket notebook, in which form the earlier publication had appeared, and the subject matter was again revised and put in somewhat different form and published as Bulletin 55 under the title "Soils of the United States, Based upon the Work of the Bureau of Soils to January, 1908." Again two years later the work was revised to January 1, 1910, and published as Bulletin 78. In the present volume the work is revised again and brought down to January 1, 1912, combining the features of Bulletin 55, which treats of the soil series, and of Bulletin 78, which treats of the soil types. In addition, a discussion of the methods of soil classification has been included, which, together with the large amount of new information gathered, makes the bulletin considerably larger than the earlier works and a very complete handbook of the soils of the United States.

I recommend that this be published as Bulletin No. 96.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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SOILS OF THE UNITED STATES.

INTRODUCTION.

By Curtis F. Marbut.

PROGRESS OF THE SOIL SURVEY.

A soil survey exists for the purpose of defining, identifying, mapping, classifying, correlating, and describing soils. The results obtained are valuable in many ways and to men of many kinds of occupation and interests. To the farmer it gives an interpretation of the appearance and behavior of his soils and enables him to compare his farm with other farms of the same and of different soils. The soil survey report shows him the meaning of the comparison and a basis for working out a system of management that will be profitable and at the same time conserve the fertility of his soil. To the investor, banker, real estate dealer, or railway official it furnishes a basis for the determination of land values. To the scientific investigator it furnishes a foundation knowledge of the soil on which can be based plans for its improvement and further investigation by experiment. To the colonist it furnishes a reliable description of the soil.

AREA SURVEYED.

There have been surveyed and mapped to January 1, 1912, a total of 520,234 square miles or 332,949,778 acres. This mapping has been done on scales ranging from 1 inch equals 1 mile to 4 or 6 inches equals 1 mile in reconnoissance surveys. In addition to this an area of about 58,000 square miles in the Ozark region of Missouri and Arkansas has been mapped in a more general reconnoissance. Including this and estimating the amount of work done in the 6 months from January 1 to June 30, the end of the fiscal year, it is estimated that there have been completed to the latter date 622,595 square miles, an area nearly equal to the combined area of four of the most important countries of Europe, as follows:

	Square miles.
Germany	208, 780
France	207, 054
Great Britain and Ireland	221, 391
Italy	110, 659
Total	647, 884

DISTRIBUTION BY PROVINCES.

For the purposes of soil classification the United States has been divided into 13 subdivisions, 7 of which, lying east of the Great Plains, are called soil provinces, and 6, including the Great Plains and the country west of them, are known as regions.

A soil province is an area having the same general physiographic expression, in which the soils have been produced by the same forces or groups of forces and throughout which each rock or soil material yields to equal forces equal results.

A soil region differs from a soil province in being more inclusive. It embraces an area the several parts of which may on further study resolve themselves into soil provinces.

Soil provinces and soil regions are essentially geographic features. They are differentiated on the basis of geographic features rather than on that of soil character.

The soils occurring in a province are brought together into groups on the basis of certain characteristics of the soils themselves, each group constituting a soil series.

A soil series may be defined, therefore, as a group of soils having the same range in color, the same character of subsoil, particularly as regards color and structure, broadly the same type of relief and drainage, and a common or similar origin.

The soils of a soil province may be grouped on the basis of the soil texture also, and a group of soils within one or more provinces, all having the same texture, belong to the same soil class. A soil class, therefore, includes all soils having the same texture, such as sands, clays, loams, etc. A soil class is not limited in its occurrence to a soil province, but the same class occurs in all the provinces or regions.

The soil unit or the soil individual is the soil type. It connotes all the features named above and is limited to a single class, a single series, and a single province.

A soil type, therefore, is a soil which throughout the area of its occurrence has the same texture, color, structure, character of subsoil, general topography, process of derivation, and usually derivation from the same material.

The soil province is named in accordance with some generally accepted terminology for the area represented or according to the processes by which its soil material was formed. A soil series is named from some town, village, county, or natural feature existing in the area when it was first encountered. The class name is wholly descriptive.

The following table shows the number of soil series and soil types that have been recognized in the several soil provinces and regions to January 1, 1912:

Number of soil series and soil types mapped to Jan. 1, 1912.

Soil province.	Series.	Types.	Soil province.	Series.	Types.
Piedmont Plateau province	21	75	River Flood Plains province	75	244
Appalachian Mountain and Plateau province	24	81	Great Plains region	67	164
Limestone Valley and Upland province	19	48	Rocky Mountain region	17	39
Glacial and Loessial province	47	142	Northwest Intermountain region	21	49
Glacial Lake and River Terrace province	38	164	Great Basin region	10	35
Atlantic and Gulf Coastal Plains province	68	238	Arid Southwest region	6	25
			Pacific Coast region	121	346
			Total	534	1,650

Soil provinces of the United States and the area surveyed in each to Jan. 1, 1912.

Province.	Estimated area.	Area surveyed.	
	Acres.	*Acres.*	*Per cent.*
Piedmont Plateau province	47,214,000	12,193,082	25.8
Appalachian Mountain and Plateau province	84,837,000	26,932,477	31.7
Limestone Valley and Upland province	67,870,000	10,089,662	14.9
Glacial and Loessial province	385,083,000	48,995,564	12.7
Glacial Lake and River Terrace province	42,788,000	10,847,498	25.3
Atlantic and Gulf Coastal Plains province	218,362,000	60,119,138	27.5
River Flood Plains province	75,247,000	21,673,659	28.8
Great Plains region	331,968,000	120,399,738	36.2
Rocky Mountain region	265,575,000	1,161,920	.5
Northwest Intermountain region	75,984,000	2,160,132	2.9
Great Basin region	118,034,000	1,111,072	.9
Arid Southwest region	81,148,000	1,375,258	1.7
Pacific Coast region	109,180,000	15,890,578	14.6
Total	1,903,290,000	332,949,778	....

The amount of work done to January 1, 1912, as shown in the foregoing table, is equal to 12.3 per cent of the entire United States, but deducting the 540,741,000 acres in the sparsely settled Rocky Mountain, Northwest Intermountain, Great Basin, and Arid Southwest regions where the survey has covered 5,808,382 acres, or approximately 1 per cent, the amount of work done in the remainder of the United States is equivalent to 24 per cent of the area. Including the Ozark survey and the estimated area done from January 1 to June 30, 1912, the area covered is 28.8 per cent of the area of the country outside of the sparsely settled regions above referred to.

DETAILED AND RECONNOISSANCE MAPPING.

The soil survey has been made and the maps published for the most part on two different scales, according to the density of settlement, the uniformity of the soils of the region, and the degree of detail intended to be shown on the map. In most of the work in the Great Plains region, where the country is sparsely settled, the soils uniform over large areas, the precipitation light and uncertain, and where intensive development may not be expected for a long time, the scale has been 4 miles to the inch. On this scale the smallest unit that can be shown on the map is 125 or 150 acres. On such a scale in localities where the soil types are much mixed by reason of rough topography, complex structure, or variable conditions of soil formation and deposition, only the soil material or what is called the soil series, which may include a number of related soil types, can be recognized. Over most of the remainder of the country the scale has been 1 mile to 1 inch, and on this scale areas of 8 acres may be readily shown, and each soil type recognized and shown separately on the map. The work on the former scale, which is called reconnoissance work, is of course much less expensive per square mile, but is wholly inadequate for a well-settled country, especially where intensive methods of agriculture are or should be used. In both kinds of work there are encountered, of course, areas of miscellaneous material such as Rock outcrop, Rough stony land, Sandhill, Swamp, and other material which is either nonagricultural or can be used for agriculture only by expensive reclamation methods. These are not properly soil types.

There have been surveyed on the detail scale 162,528,210 acres and on the reconnoissance scale 178,913,280 acres, with an overlap, or duplication of territory, of 8,510,272 acres.

SOIL CLASSES BY PROVINCES.

The following table shows the percentage distribution of the different classes of soils in the several provinces:

Relative proportion of the different classes of soils in the United States based on the surveys to Jan. 1, 1912.

Province.	Sands.	Fine sands.	Sandy loams.	Fine sandy loams.	Loams.	Silt loams.	Clay loams.	Clays.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Piedmont Plateau province	0.1	....	37.8	5.6	21.5	4.6	8.1	22.3
Appalachian Mountain and Plateau province	2.4	....	8.4	7.8	32.8	18.1	24.6	5.9
Limestone Valley and Upland province	....	....	.9	.1	59.3	26.0	7.7	6.0
Glacial and Loessial province	4.6	1.4	4.9	3.7	24.5	48.8	12.1	....
Glacial Lake and River Terrace province	10.5	6.6	16.9	9.8	21.8	6.6	10.1	17.7
Atlantic and Gulf Coastal Plains province	9.3	10.9	13.7	34.9	9.1	4.1	6.0	12.0
River Flood Plains province	.9	1.8	2.1	12.6	13.0	35.3	1.6	32.7
Great Plains region	1.7	2.2	3.1	13.7	11.7	50.4	14.7	2.5
Rocky Mountain region	12.6	5.0	13.0	15.2	15.7	1.8	31.9	4.8
Northwest Intermountain region	8.9	9.1	3.9	33.9	22.6	20.0	.8	.8
Great Basin region	3.6	3.2	22.4	21.5	20.5	.0	26.4	2.4
Arid Southwest region	12.2	.3	25.4	18.7	7.8	14.3	9.2	12.1
Pacific Coast region	10.1	1.4	21.9	9.7	18.0	19.4	9.3	10.2

Certain peculiarities in this table will be pointed out and explained in treating of the forces which have operated in the formation of the soils of each province. In the Piedmont Plateau province the sandy loams, loams, and clays predominate, and the reason for this will become apparent when the forces which have been operative are understood. In the Appalachian Mountain and Plateau province, the loams and clay loams predominate. In the Limestone Valley and Upland province the loams and silt loams predominate, with no distinctive sands or fine sands. In the Glacial and Loessial province the silt loams predominate, with no distinctive clay soils; while in the River Flood Plains province there is nearly twice as large a percentage of clays as in any other province and the silt loams are equal in extent to the clays. In marked contrast to the other provinces is the relatively large area of sands, fine sands, sandy loams, and fine sandy loams of the Glacial Lake and River Terrace

province and the Atlantic and Gulf Coastal Plains province, for reasons which will be readily understood when the forces which have acted on the soil material are explained.

Taking the soils as a whole, so far as they have been classified into types, the dominant soils of the United States are the silt loams, with the other classes following in this order: Loams, fine sandy loams, clay loams, sandy loams, clays, sands, and fine sands, as shown in the following table:

Total area of different classes of soils.

Class.	Acres.	Per cent.	Class.	Acres.	Per cent.
Silt loams	59,682,353	27.0	Clays	20,491,040	9.3
Loams	38,488,285	17.4	Sands	11,018,828	5.0
Fine sandy loams	35,786,147	16.2	Fine sands	9,164,862	4.2
Clay loams	23,709,868	10.7			
Sandy loams	22,456,224	10.2	Total	220,797,607	....

PROCESSES OF SOIL FORMATION.

Probably the most widespread impression obtained from textbooks regarding the origin and formation of soils is that soils are derived directly from rocks through the influence of weathering and the breaking down of the rock in place, leaving a disintegrated mass of material on the surface which constitutes the soil. This is only remotely true. All soils are derived from disintegrated rock material, but large areas of soils are not derived from the disintegration of rocks which lay in the same vertical or horizontal position as that occupied by the soil. The rock material from any locality or from any one kind of rock may have been carried from the place of formation, mixed with material from other localities and other rocks, and deposited in another locality either with or without sorting according to size and weight of particles. Not over 2 per cent of the soils that have been surveyed in the United States are derived from material resulting from the disintegration in place of crystalline and metamorphic rocks, and probably not over 5 per cent has been derived from the disintegration in place of secondary rocks, such as sandstone and shale, so that the greater part of the soils which cover the surface of the United States is derived from material that has been transported from the locality where it was formed from the disintegration of rocks and deposited in its existing locality, often far from the parent locality. Upward of 90 per cent of the soils that have been surveyed are derived from material that owes its existing occurrence and distribution to the action of moving water, moving ice, and moving air. It has been carried from the place where it was formed as rock débris by weathering agencies and redeposited in its existing position. During the period of transportation the materials from many kinds of rocks have become thoroughly mixed, so that the soils as we encounter them are generally more heterogeneous and complex mineralogically than at the several points of origin of the material, where it was necessarily limited in its range of characteristics by the nature of the rock whence it was derived.

The forces of disintegration and decomposition convert the rock material into available soil material. The forces of transportation and sedimentation reduce further the sizes of the particles and lay them down in their new position more or less assorted according to size and weight. The conditions to which the newly deposited material is subjected and the weathering of the untransported material after its disintegration change both kinds of material profoundly. The transported material, however, is subjected in most cases to more profound changes than that that has never been transported. These subsequent changes of further weathering, of accumulation of organic material, of increasingly favorable conditions for the development of bacterial and other forms of life are the changes that convert the disintegrated rock material into a soil.

The untransported rock material is being acted upon during its formation from the parent rock so that by the time disintegration has extended to a depth sufficient to form a soil the surface material has already become a soil through the combined action of weathering and life. The transported material laid down in any considerable depth of water becomes, however, in its new position raw rock material. Bacterial life is destroyed and organic accumulations dissipated. It is set backward to a much more primitive stage of development than the closely related material that was not removed from its parent locality. The conditions to which this new material is subjected after deposition may be profoundly different from those to

which the original untransported material is subjected. Material removed from a barren, excessively drained hillside and transported by water to a swamp and left for ages under these conditions may be the same mineralogically as when it left the hill. In its new position, however, it is subjected to conditions which favor the accumulation of vegetable matter, impede drainage, diminish aeration, make it unfavorable to the development of certain bacterial life, and retard chemical change or such change as takes place in soils that have good aeration. The accumulated effect of these conditions is to change it markedly.

The sorting of the material which is effected in its transportation and redeposition affects profoundly the rapidity with which the subsequent soil-forming agencies act. On an area of open porous sand they operate rapidly; on a poorly drained clay they operate much more slowly and probably in a different way. It is of vast importance, therefore, in the classification of soils to recognize not only the character of the rock from which the material has been derived but also the agencies which have acted in the transportation and deposition of the soil material and the changes which have taken place since its deposition. The character of the parent rock material, with the influences of general physiography dependent upon this, the transportation and redeposition of such material or its sedentary character are the factors on which the soil province is based. The changes which have been wrought in the material since its deposition or in the case of untransported material since its formation, together with the influences in minor differences in rock character, are the factors on which the next larger grouping of the soil, the soil series, is based.

SOILS OF THE PROVINCES.

The soils of the Piedmont Plateau are derived directly from the disintegration and more or less complete decomposition of igneous and metamorphic rocks and a relatively small area of shales and sandstones in the northern Piedmont which have not been metamorphosed. The general physiography, however, of this sandstone area is the same as that of the area of crystalline rocks. The soils are residual soils in both cases. The main factors, therefore, on which the existence of this province is based are those of origin or process of formation of soil material and general topography. Rock character is of subordinate importance.

The Cecil series is derived from the coarser grained crystalline rock, the granites and gneisses, and comprises material that has reached a mature stage in soil weathering. The Louisa series of soils is derived from the micaceous crystalline rocks, such as the schists, and, like the Cecil, comprises material that is maturely weathered. The Penn soils are derived from a series of red shales and sandstones which have not been metamorphosed and comprise well-weathered material, while the Alamance and Georgeville soils are derived from slates, both thoroughly weathered and oxidized, the latter to a red color and the former to a yellow color.

The Durham soils are derived from granites and gneiss of a highly quartziferous nature. Either on account of immature oxidation or a relatively small content of ferruginous material they are yellow rather than red in the subsoil. The Iredell soils, on the other hand, are derived from quartz-free crystalline rocks and under conditions that have not permitted the thorough oxidation of the subsoil. They therefore are soils with heavy gray, yellow, greenish, or mottled sticky plastic subsoils. From the same rock, for example a quartz schist, may come gray soils with red subsoils and gray soils with yellow subsoils, the difference, due to some inequality in the rock mass or in the stage of weathering reached, being sufficient indication of inherent differences of functioning to warrant mapping as different soil series (Herndon and Edgemont) notwithstanding a common origin.

The soils of the Piedmont Plateau being derived from the disintegration of rocks in place, have had little chance to mix, except from wind action, and would show marked uniformity in texture of material over similar rock areas (as indeed they do in the deep subsoil) were it not for rainwash. Over most of the southern Piedmont the subsoil material is a red clay, remarkably uniform in texture, but nearly half of the area is covered with a sand or sandy loam some 6 to 18 inches deep, resting directly on the red clay and undoubtedly formed by the carrying off of the fine silt and clay particles in gentle rills over the more level portions of the fields, leaving the sand as a residual covering. This mantle is gradually deepened as various agencies like insects, overturning trees, and cultivation, bring the underlying material to the surface for the rains to act upon. On steeper slopes the run-off of rain water has been sufficiently swift to erode and carry the soil away bodily, removing at once both the fine and coarse material, leaving a clay covering of the surface or exposing the bedrock.

The soils of the Appalachian Mountain and Plateau are similarly derived from the disintegration and, to a certain extent, decomposition of rocks in place, but these

rocks, unlike most of those of the Piedmont Plateau, were themselves formed of material which had previously been transported by moving waters, separated and segregated by wave and current action, and afterwards consolidated. We have here, then, several different shale and sandstone formations which, to start with, owing to differences in the original source or character of the material out of which the rock was consolidated, to conditions under which the material was laid down or to influences acting before or after its consolidation have different colors. And we have again soil material which differs in color in top soil or subsoil owing to differences in drainage or other conditions acting during and subsequently to rock disintegration. These color differences are indicative of differences in the functional activities of the soils of sufficient importance to justify classification of the material into distinct soil series notwithstanding the fact that the rock origin may be, so far as can be seen, identical. It is interesting to observe that although many of the rocks of this region are relatively coarse grained sandstones, there have been practically no distinctive sands or fine sands encountered in this province.

The soils of the Limestone Valleys and Uplands are similarly derived from the disintegration of rocks in place but a very different class of rocks from those of the Piedmont or Appalachian provinces and disintegrated in a very different way from those of either of the soil provinces just considered. These rocks consist of a mixture of calcium carbonate in the form of small grains or larger crystalline masses of calcite mixed with an amount of noncalcareous material, usually clay, silt, and sand, varying from place to place horizontally and from bed to bed vertically. As originally deposited on the sea floor this material was soft and unconsolidated. Through pressure and the more or less complete crystallization of the calcium carbonate the material has been consolidated into beds of hard limestone rock.

The amount of noncalcareous material varies greatly from practically nothing up to a pure noncalcareous rock. Interbedded with the calcareous rocks, therefore, may occur shales and sandstones, but they are usually thin so that in the disintegration, decomposition, and mixing incident to soil formation their material becomes mixed with that from the purer limestone rocks. The limestone beds may become impregnated also with siliceous material in the form of chert.

Unconsolidated calcareous deposits are still to be found in other parts of the country, and in many places, especially in swamps and in the arid and semiarid regions, clays and sands have become highly impregnated with calcareous material, concentrated in such places in recent times, but the conditions in the Limestone Valleys province are not of this kind. The rocks of this province are highly resistant to the physical forces of disintegration, such as change of temperature, but are readily attacked by the chemical processes of rock weathering, especially by solution. Only the calcareous constituent of the rocks is easily dissolved, however. The noncalcareous constituents are left behind, together with a varying but small percentage of the calcareous constituent, to form soil. In fact, the soil is often found to be remarkably free from calcareous material.

From what is recognized as a pure limestone, we may have black, brown, red, gray, or white soils with gray, brown, red, or yellow subsoils, depending upon the conditions under which the soil material has accumulated and to which it has been subjected. These varying colors indicate sufficient difference in the functional properties of the soil material to justify its classification into different soil series.

The soils of the Glacial and Loessial province are derived from material whose origin differs entirely from that of the provinces just considered. The glacial soils will first be considered and then the loessial soils. The glacial soil material has been formed and moved to its existing position by moving ice, which has collected rocks and finer material, often from distant localities. This material, after much grinding and mixing, the ice has left upon its recession in deposits frequently hundreds of feet thick. All of this material is designated as drift. The greater part of it was dropped from the ice and left without further movement, while a smaller portion was taken up by the waters derived from the melting ice and distributed as sorted material within, under, on, or beyond the ice. There are two kinds of material, therefore, in the glacial part of the Glacial and Loessial province—unassorted and unstratified material and assorted and stratified material. None of this material has been disintegrated from its parent rock and left in place as were the materials of the Piedmont, has not been previously assorted, as was the case of the rocks of the Appalachian Mountain and Plateau province, nor has it come as a result of solution of rocks and the carrying away of the major portion in solution as in the Limestone Valleys and Uplands province, but it does represent material from hard igneous and metamorphic rocks, limestone, sandstone, shale, and unconsolidated deposits mixed together. In the unassorted drift the fine material is mixed heterogeneously with the coarse, the sizes ranging from the finest clay to large bowlders. In the assorted drift

the finer particles have been deposited in one locality or one layer and the coarser particles in another.

West of the Allegheny plateau the glacial deposits were laid down on a relatively smooth country. Although the total amount of such deposits per square mile seems to be about equal to that on the same area in the northeastern States, yet because of the smooth country on which they were deposited they mantle it completely, so that exposures of the underlying rock are much more rare than in the rougher country east of Ohio. Such inequalities of topography as existed in the preglacial surface were obliterated in a large part of this region, leaving a topography dominated almost completely by the glacial deposits themselves.

As a whole there seems to be a somewhat greater heterogeneity of material west of the Appalachian region than within it. This is not great enough, however, to cause the predominance of local material in the drift in this region to be as characteristic a fact as is the case elsewhere. In Ohio, Indiana, and Wisconsin, and apparently the same is true elsewhere, the boundaries between large areas of the different kinds of rock may be determined with approximate accuracy by an examination of the drift.

From this material inorganic and organic agencies that have been operating since the deposition of the material have produced the black or brown soils and the yellow or white subsoils of the Carrington, Miami, Shelby, and Williams series, differing markedly in appearance and properties as a result of the character of the material, the conditions under which they were laid down, and the conditions to which they have since been subjected.

East of the Ohio-Pennsylvania line, however, the glacial deposits, excepting a narrow belt lying just south of Lake Ontario, were laid down on a topography of strong relief. The ice was concentrated, especially during the later stages of its disappearance and the period of maximum deposition, in deep valleys. On the uplands, therefore, excepting areas of relatively smooth upland plateaus, the glacial deposits are thin, while in the valleys they have accumulated often to great thickness. Even where they are thick, however, the predominance of local material or of material whose parent locality was not far away is very striking. In northern Pennsylvania the glacial deposits are almost exclusively made up of sandstone and shale material exactly like the rocks beneath the drift. In northern New Jersey the material is mainly shale in the Kittatinny Valley, except the rather abundant Kittatinny sandstone material along the western side of the valley, crystalline gneiss in the Highland region, and mixed crystalline and Triassic material in the Piedmont belt east of the Highlands. In the New England States the glacial material is almost entirely from crystalline rocks, except the Triassic sandstone material in the Connecticut lowland belt, the limestones of the Berkshire Valley, and the sandstones of the Narragansett coal basin. It is known that certain areas in the extreme northern part of New England must be excepted from this general statement, but to what extent has not been determined. In the Lake Ontario belt of New York the material seems to partake less of the local underlying rocks than elsewhere.

The soils, therefore, east of the Ohio-Pennsylvania line are derived from glacial deposits consisting mainly of sandstone and shale, mainly of shale, mainly of crystalline gneisses and schists, and mainly of limestone, and in some cases of material made up of two or more of these without the striking predominance of either. In all cases the derivation of the material is determined on the basis of the character of the stone and gravel in it.

Each kind or mixture of glacial material gives rise to a number of soil series differing in accordance with the conditions under which the material was laid down or which have existed since its deposition. The top soils may be black, brown, yellow, white, or gray and the subsoil may differ as greatly in color and other physical properties, indicating differences in functional activities amply justifying the classification adopted.

Over approximately the southern third of the Glacial and Loessial province, west of the Ohio-Pennsylvania State line, the glacial material is covered with rather a thin mantle of silty material, whose derivation has not been definitely determined in all cases. Some of this material is clearly loessial, such as that lying along the bluffs of the Missouri and Mississippi Rivers. In other cases its origin is not so clearly evident from its distribution, relations, and character. Over most of its area of occurrence, except the rather narrow river-bluff belts and certain areas in close association with the terminal moraines of some of the glacial periods, this material occurs as a rather thin layer mantling the ice-laid deposits without producing any essential change in its relief. The river-bluff belts are thick and very little change in texture takes place in the material from the surface downward, but the thinner deposits are highly silty on the surface and become much heavier within a few inches from the surface.

The essential fact, from the soil point of view, that is common to all this material is that it is very silty on the surface at least and practically, though not entirely,

stone free throughout its whole thickness. It is a well-known fact, based on the studies of this material by Chamberlain many years ago in Wisconsin, that in the river-bluff belts it is very heterogeneous in mineral composition. Whether this heterogeneity is universal and coextensive with the distribution of both its thick and thin phases has not been determined. According to the conditions under which it was formed or that have existed since its formation it exhibits itself now as black, brown, or white on the surface and yellow, drab, or gray beneath, indicating marked differences in functional activities and physical properties of the material justifying its classification into a number of soil series. One peculiarity of this province is that no distinctively clay soils have been recognized.

The soils of the Glacial Lake and River Terrace province are reworked glacial débris and are thus still further removed from definite and specific rock origin. The material carried by the glacial rivers into the old glacial lakes has been subjected first to the assorting action of the flowing streams and then to the wave and current action of the lakes, with the result that considerable areas of clay soils have been encountered where the deep and quiet lake waters formerly covered the surface and considerable areas of sands where the waters were shallower and more turbulent.

All of these glacial-lake deposits are of very recent age. Aside from river flood-plain deposits which are still in process of formation they are the most recent deposits of any considerable extent in the country. The forces of erosion have only begun their work and have made so little advance that the land surface where these deposits occur is still essentially as it was when the lake waters were drained off. The first step, therefore, in the classification of the soils is to separate them according to present drainage conditions into those in which drainage has become well established, in which the proportion and circulation of water and air are normal for general farm crops, and into those in which the soils are so very young that drainage has not been sufficiently established and indeed in some of the material such as peat and swamp soil functional activities are so immature that they can not as yet be considered as soils at all.

Under each of these heads the material is further classified according to color of soil and subsoil into black, brown, red, or yellow top soil and black, brown, yellow, red, or white subsoil; into calcareous and noncalcareous material where these differences are marked; and with respect to gravel and hardpan layers, friability, and permeability of topsoil and subsoil. Where the material has been derived from feebly glaciated areas and the general rock origin can be determined, this has also been used as a basis of classification so far as seems justified as a basis of classification and separation of material into soil series.

The materials of the Coastal Plain province were laid down in the relatively shallow water of the Atlantic Ocean and Gulf of Mexico when their shore lines lay considerably farther inland than they lie at the present time. These materials were laid down not only in shallow water, but relatively near the shore also, taking them as a whole. Along the Atlantic portion of the belt the continental slope was and is relatively steep; the inland position of the shore line with a given amount of change of level was relatively small. This part of the Coastal Plain is therefore relatively narrow and all its parts were near the former shore line. The shore line also lay near the Appalachian Mountains, from which swiftly flowing streams carried relatively coarse material and deposited it in the sea. It is inevitable, therefore, that in that part of the belt where it is comparatively narrow, and, more important still, in that part of it where the land area from which it received its deposits was mountainous, these deposits must be coarse in grain.

In the western part of the belt, however, including the States of Mississippi, Louisiana, Arkansas, and Texas, the shore line lay far inland and the rivers which carried material into the sea flowed over broad areas of smooth plains before reaching the sea. Their grades were therefore gentle and their loads of suspended material correspondingly fine in grain. In this part of the belt, therefore, there is a much larger percentage of clay and silt deposits.

The soil material is so heterogeneous and so remote from specific rock origin that this factor can not be taken into account in the classification. It is noticeable, however, and the fact is used in the classification of soils, that in certain parts of the province there is soil material unlike that found in any other portion, and this is associated in a general way with the origin of the material.

In that part of the Coastal Plain north of the drainage basin of the Potomac River, where for physiographic reasons its latest deposit must have come from the Glacial, Piedmont, and Appalachian provinces, there are characteristic soils not found elsewhere. There are distinctive soils also in that portion of the Coastal Plain between the Potomac and the Mississippi River drainage basin where the material has come mainly from the Piedmont and Appalachian.

The last extensive deposit of material that was spread over the Coastal Plain consisted of gravels and sands. Its distribution is the widest of any of the known Coastal Plain deposits, so that it must have covered the whole area not like a mantle, but like a flood wiping out preexisting topography. There is still some question as to the origin of this deposit—whether it was laid down in the sea or distributed over the surface of the land by rivers dividing and redividing into many distributaries. So far as soils or soil classification is concerned the settlement of this question can be left to geologists. The significant fact from the soil point of view is that there was a final deposit of sand, clayey sand, and gravel spread over the Coastal Plain region. Where areas of original undissected portions of the Coastal Plain still exist the soils are derived from this material. Such areas, however, are of rare occurrence, so that most of this material has become mixed with that from other Coastal Plain deposits or furnishes a coating over these.

Under each of the main divisions of the Coastal Plain there are the older soils, functionally, where drainage is well established, and the younger soils, where drainage is as yet poorly established, and in each of these groups are materials of different color in top soil and subsoil, of different conditions of plasticity, of hardpan and gravel substratum which exhibit sufficient differences in functional activities to justify their separation and classification as distinct soil series.

The River Flood Plains province occupies a somewhat intermediate place between the Coastal Plain and the other soil provinces. The rivers receive material from each of the soil provinces and carry it down more or less directly and quickly to the coast to be worked over into some future extension of the Coastal Plain, or they leave it, for the time being at least, as a valley filling in the form of bottom lands or terraces now far above present overflow of the stream.

Unlike the Coastal Plain province, which has a very large proportion of sands and sandy loams, the River Flood Plains province has practically no distinctively sand soils, except such as have been left in old abandoned channels and in the bottoms along the smaller streams. There is even very little sandy loam.

Rivers do not begin the formation of a flood plain until they have reached grade or established a profile of equilibrium—a balance between the fall and the character of the load carried. This stage in the life of a stream is reached only after the country drained by it has attained a relatively advanced stage of development, after the whole drainage basin has been dissected and valley slopes not only produced but worked backward to a weathered slope—in short, a stage in which the material delivered to the streams is chemically weathered material rather than mechanically weathered material. The predominant material is therefore relatively fine in grain. The streams adjust their slopes or grades to the character of this predominant material. The velocity of the streams becomes a velocity sufficient to carry in suspension material of this size as a maximum. What coarser material is delivered to the stream, therefore, is left in the channel serving to build it up or else is rolled along the bottom. The significant fact is that this coarse material is not carried in suspension. When the stream overflows its banks and spreads over its flood plain the coarsest of the suspended material is deposited near the channel, building up a channel belt rather rapidly, corresponding in the long run to the rate of upbuilding of the channel bottom by the material too coarse to be carried in suspension. The finer suspended material is deposited in the places where the flood waters became practically stagnant. Since sands and gravels are not carried in suspension they can not be deposited on the flood plains. These, however, where they have been rolled along the bottoms of the channels, as is the case of rivers to which they are delivered by their tributaries, are found as a more or less deep substratum underlying the material deposited from suspension.

The River Flood Plains province, extending as it does like fingers through all the other soil provinces, to pick up through the agency of the rivers, streams, and rivulets material from each acre of land, contains a very heterogeneous mixture of rock material, but the principal source of this material can usually be traced at least to the soil province from which it was derived. Thus we have a division of the River Flood Plains province made up of material of mainly glacial origin; another division of the Piedmont material; and so for Appalachian, Appalachian and limestone mixed, Appalachian, limestone, and Piedmont mixed, Glacial and Appalachin mixed, loessial material, Coastal Plains, and Residual Prairie material. Each of these divisions show soil-forming material differing markedly from the same material in its original position. Thus the Congaree series is derived directly from Piedmont material and still shows some of the characteristics of Piedmont material, but the Congaree is entirely unlike any of the specific Piedmont series. It has certain River Flood Plains characteristics which show definitely to which province it belongs and enough of the

Piedmont characteristics to show in what division of the River Flood Plains province it falls.

In many parts of the country the former flood plains of the streams, especially of small streams, have been covered by a coating of considerable thickness of colluvial and alluvial fan material washed in from the valley slopes. This has taken place as a consequence of the clearing and cultivation of these slopes and their consequent severe erosion. Nature's cover of vegetation before the advent of man to the region protected them from excessive erosion to such an extent that the stream in the adjacent valley was able to control the material delivered to it and to distribute it in accordance with its current. The sudden great increase of material washed into the valley, however, in recent years has completely overloaded the stream, rendering it wholly incapable of shaping its flood plain as formerly. The new material is dropped, therefore, by the small rills as soon as their carrying power is checked on reaching the bottom of the valley slope. It accumulates as alluvial fan material and varies in texture from place to place and from top downward very greatly, depending upon the amount of water and its distribution in each rill that made the deposit. It was not deposited, therefore, under the uniform conditions existing in every flood plain, but under the local conditions existing for each hillside rill. It has no uniform texture therefore. It has been mapped by the soil-survey field men as Meadow. It not only lacks uniformity in texture over any mapable area, but it is as a rule poorly drained. This is also the case with other phases of river flood-plain deposits, so that a first stage in the classification is to divide the material in each division of the province into mature soil with drainage well established and less mature soils with drainage poorly established. In each of these subgroups the color of top soil and subsoil the presence of gravel layers or of iron or lime concretions, the porosity of the material, the stage of oxidation, particularly of the substratum, and the elevation above normal or flood-water level of the streams are all considered in the classification and final establishment of the several soil series.

It is impossible to give in any written document the many natural phenomena that assist the field man in the mapping and classifying of soils. Experience has taught him to associate with a change in soil type, conditions such as the topography and physiography, the kind of native vegetation and the character of growth, the physical peculiarities of road cuts, the records of well borings, the form of surface erosion, the feel of the soil, and other obvious physical characters. All these he has come to look for and value, as his experience dictates, in confirmation of his judgment as to the proper place for the material in the scheme of soil classification.

Having given this general statement describing the forces which have operated to form the soils of the seven great soil provinces into which the eastern half of the United States has been divided and of the basis of classification of the different kinds of material or the soil series in each province, it will be unnecessary to describe the western soil regions, for these are each described at length in subsequent pages. It will be seen that each of these regions is subdivided into seven divisions, corresponding with the eastern provinces, and that the same forces have operated here as in the East. All these matters are also shown in the diagrammatic keys placed at the end of the section devoted to each province and region. In these keys the differences in the soil series can be seen at a glance.

SOILS OF THE PIEDMONT PLATEAU PROVINCE.

By Hugh H. Bennett.

DESCRIPTION OF THE PROVINCE.

BOUNDARIES.

The Piedmont Plateau comprises the rolling to hilly region lying between the eastern foot of the Appalachian Mountains and the Atlantic Coastal Plain. The northern end of this province lies in northeastern New Jersey, along the glacial boundary, in the vicinity of the Hudson River. It extends southwestward through New Jersey, across southeastern Pennsylvania, central Maryland, and the District of Columbia to central Virginia in a belt ranging from 20 to 50 miles in width. Widening here, it continues in a southwesterly direction across Virginia, central North Carolina, western South Carolina, and northern Georgia, to the vicinity of Clanton, in central Alabama, with an average width of approximately 115 miles. The province has a length of 900 miles and embraces an area of approximately 73,770 square miles.

TOPOGRAPHY.

While the region exhibits a diversity of topographic forms, it has certain general features which define it as a distinct topographic unit. The general surface configuration is that of a broad plain of moderate elevation sloping gently southeastward. It is dissected by the valleys of intricate systems of perennial streams and intermittent drainageways. The valleys, gorges, and gullies of these waterways have invaded the region so thoroughly that no areas of any considerable size remain entirely undissected. The topography may be broadly characterized as rolling to hilly and ridgy. The valley slopes are usually smooth and rounded rather than rough and angular, so that a large proportion of the region is tillable from the edge of the stream bottoms to the crests of ridges and tops of hills. Areas of rough, gullied land are not uncommon, however, especially in some localities near the Coastal Plain border and in the vicinity of the deeper valleys of the major streams. These gullied areas are more common in that part of the province lying south of the Chesapeake Bay section than north of this section.

The broader stream divides are naturally smoother than the narrow ridges between the deep stream valleys. Over many of these broad divides there are plateaulike areas of considerable extent which have a gently rolling to undulating topography. Also the relief is not so pronounced over much of the border zone, where the Piedmont frequently grades imperceptibly into the Coastal Plain. There are many scattered patches and some considerable bodies of distinctively flat to undulating or gently rolling land where the uniform weathering of the underlying rocks has favored the development of a smooth topography. This is true of areas of the Iredell soils, derived from diorite and associated rocks. These soils have a prevailingly smooth topography and usually occupy peculiar low, basinlike positions with respect to the surrounding soils underlain by granites, gneisses, and schists. The soils derived from rocks of the included Triassic basins, particularly the Penn group, are characteristically much less rolling in topography than those from the granitic, gneissic, and schistose rocks.

The sky-line of the Piedmont country as seen from one of its summits stands out with striking evenness, except for an occasional conspicuous hill or ridge reaching sometimes several hundred feet above the general upland level. These isolated, prominent elevations, known as monadnocks, represent areas where the rocks have been more resistant to the effects of weathering, and show a correspondingly slower wearing down of the surface by erosion. Notable examples of monadnock hills and ridges are Kings Mountain in North Carolina, Southwest Mountain in Virginia, and Sugar Loaf Mountain in Maryland.

The seaward border of the province for a considerable distance is fairly sharply defined by the "fall line," constituting a border zone through which the waters of the larger Piedmont streams cascade over rocky ledges or rush swifty over rocky bottoms of

ocally accentuated slope directly into navigable waters of Coastal Plain streams, either of a tidal character or of relatively slow current. The boundary is not everywhere distinct, either as regards topography or character of soil. In places there is a zone having only a thin apron of Coastal Plain material overlapping the Piedmont formations, and including frequent outcrops of soil of the latter province. Here the topography is often of no assistance in locating the boundary, and the soil frequently must be very carefully examined in order to establish the true line of separation.

From the base of the Blue Ridge Mountains in Georgia, North Carolina, and Virginia, of Catoctin and South Mountain in northern Virginia, Maryland, and southern Pennsylvania, of the Durham and Reading Hills of eastern Pennsylvania, and their extension, the Highlands of New Jersey, in northern New Jersey, the Piedmont Plateau gradually descends to the southeast from an elevation varying from 700 to 1,500 feet along the inner margin to altitudes of 100 to 700 feet along the Coastal Plain boundary. Both the seaward and inland borders rise gradually from the lower altitudes in New Jersey, Pennsylvania, and Maryland, to the highest elevations in Virginia, the Carolinas, and Georgia.

Inasmuch as the boundary line between the Piedmont and Appalachian provinces is mainly one of elevation rather than of distinct soil difference, it follows that the line of separation is one of intricate curvature and frequently indistinct location except as viewed in panorama. In Alabama, Virginia, and the region to the north the Piedmont occasionally abuts for short distances in relatively low positions against the soils of the Limestone Valleys. Near the western border of the province there are some occasional outlying patches of the Limestone Valleys and Appalachian provinces.

As with the Coastal Plain, the most uneven portion of the Piedmont is found immediately along the inland boundary where the hills and winding ridges rise to altitudes of 1,000 to 1,500 feet, and where the streams, though frequently representing merely headwater drainageways, have cut deep valleys. The interior portion of the province, with a lower relief than the Appalachian border zone, is ordinarily more rolling than the marginal strip bordering the Coastal Plain. The lowest elevations of the province are found in New Jersey, Pennsylvania, and Maryland.

DRAINAGE.

The primary waterways of the Piedmont divide into secondary streams which in turn divide into smaller brooks or "branches," which dwindle to mere wet-weather drainageways or "gullies." This network of waterways ramifies the region thoroughly, providing excellent drainage for the entire region. With few exceptions the larger streams traverse the region with little or no regard, so far as their general direction is concerned, for inequalities in the hardness of the rocks, crossing the province at wide angles to the northeast-southwest trend of the rock formations. In Alabama and Georgia the main streams follow for considerable distances the general direction of the strike of the rocks. The smaller streams are more dependent upon the structure and character of the rocks and their courses frequently show adjustment with the strike, following its general direction into the main drainageways. The minor ravines spread out widely, with no dependence upon the character of rock structure.

With regard to the width of the stream flood-plains, the variations of rock hardness have considerable influence. They gradually widen out within the limits of the softer rocks and narrow down or completely disappear where the streams traverse the more resistant formations. The width of the Piedmont stream bottoms averages much less than that of the streams of the Coastal Plain, owing to the more resistant character of the Piedmont rocks as compared with the unconsolidated deposits and comparatively soft rocks of the Coastal Plain. Also, for the same reason, stream terraces are very much less in evidence, and as a general rule narrower than those of the Coastal Plain.

North of the Roanoke River the headwaters of the major streams extend well out into the Appalachian Mountains and the Limestone Valleys, whereas to the south the larger streams either barely reach the Appalachian edge or have their sources completely within the Piedmont Plateau.

GEOLOGY.

The Piedmont Plateau is a region of complex rocks, including principally (1) old igneous rocks, such as diorite, diabase, gabbro, and granite, with more recent igneous extrusives and intrusives of the Triassic basins; (2) the old metamorphosed igneous and sedimentary rocks, such as gneiss, schist, phyllite, and slate; and (3) young sedimentary rocks, such as the Triassic sandstones, conglomerates, and shales. The older rocks, both igneous and sedimentary, have been tilted and warped out of all semblance to their original position. Owing to the irregularity of the disturbances in

the original positions of the rocks, to the abundance of irregularly distributed intrusives and extrusives, and to the effects of long-continued erosions, this region is one in which constructional topography is practically wanting, the surface configuration being nearly everywhere at variance with the rock structure. Some topographic conformity with the rock structure is shown in portions of the Triassic basins where the relatively smooth surface is apparently more or less dependent upon the uniformity in the character of the rocks and the comparative horizontality of their strata and consequent even weathering.

The Triassic rocks constitute a distinct geological formation, although the included dikes, as soil-formers, are essentially the same as the older, igneous Piedmont rocks. It is the sedimentaries of this group, the sandstones, conglomerates, and shales, representing consolidated sediments laid down in erosional troughs, that are so distinctly different from the igenous and metamorphic rocks of the province. These really form a subdivision of the province as regards both the character of the rocks and of the derivative soils, but their distribution and land form are such that they properly constitute a part of the physiographic region, being unlike the detached areas of the Limestone Valleys, Appalachian Mountains, and Coastal Plains. These latter represent outlying or subordinate developments of the great provinces which have their typical development outside of the limits of the Piedmont.

SOILS.

The soils of the Piedmont Plateau consist of residual products formed in place by the decay of the underlying rocks. Under the influence of the solvent action of atmospheric water, the loosening, splitting, and chipping forces of temperature changes, freezing water, and plant roots, the rocks have been loosened structurally, disintegrated, and decomposed to depths varying from a few inches to 50 feet or more, and the residues of such decay have been left in the form of a mantle of soil either directly over or near the parent rocks. Thus, with little chance for mixing the material, aside from the relatively unimportant work of gravitational creep and colluvial action, the texture and character of the soil are dependent to a very large extent upon the character of the underlying rocks.

The most effective work of water with respect to soil differentiation has consisted, first, of the washing out of the finer particles through superficial erosion to leave coarser textured surface soils, and second, of the bodily removal of superficial layers of both coarser and finer material to expose the heavier subsoils. Occasionally loamy soils have been formed on the lower slopes by the downward creeping and washing of fine particles, while in other instances, sandy material has been swept from higher elevations during torrential rains to cover with coarser textured soils the slopes originally occupied by fine material.

The two important factors which have governed soil differentiation in this province, then, have been the character of the original rocks and the effects of subsequent erosion. There has thus been far less opportunity for the wide differentiation of texture and the thorough mixing of material than has obtained in the Coastal Plain where an enormous amount of reworking by streams, waves, and tides has taken place. Accordingly the soil material of the Piedmont is much more uniform in character than in the case of soils within the Coastal Plain. Also, the Piedmont soils have a correspondingly narrower range in crop adaptation and more nearly uniform productiveness.

The control of erosion is one of the most difficult problems connected with the farming of the Piedmont soils. Especially in the southern division is much of the land peculiarly susceptible to erosion. There are many slopes and gullied areas where erosion has kept close pace with rock weathering or has removed completely the soil material. This wasteful wash can be checked if not prevented by terracing the slopes, increasing the absorptive power of the soil by deeper plowing, by incorporating vegetable matter, and by seeding the land to soil-binding grasses.

Deep sandy soils are practically wanting in the Piedmont. The subsoil portion of the normal soils of this region nearly always consists of a brittle heavy clay. The surface soils are also prevailingly much heavier than those of the Coastal Plain region, and where the surface portion does consist of sandy material it is seldom more than 8 to 12 inches deep. The friable, sandy clay subsoils of the Coastal Plain find their textural equivalent in comparatively small areas of the Piedmont lands. The sandy loams, clay loams, and clays occupy by far the greater proportion of the region.

In their distribution certain soil series, such as the Chester and Manor, are confined largely to that portion of the Piedmont lying to the north of a line crossing the province in the vicinity of Culpeper, Va., while other prominent series, such as the Cecil, Louisa, and Durham, are generally found south of this latitude. This, however, is not

an arbitrary line of separation since certain soils are developed in both divisions, the Cecil, for example, having been mapped all the way from the southern limits of the Piedmont in central Alabama to northern Maryland.

CLIMATIC INFLUENCE.

The Piedmont Plateau, running diagonally to the parallels of latitude for an approximate distance of 900 miles, extends from latitude 32° 30′ north to latitude 41° north. This broad range in latitude, coupled with a range in altitude of nearly 1,400 feet, is necessarily accompanied by a wide variation of temperature, represented by an annual mean of 66° F. in central Alabama and 52° F. in the vicinity of New York City, with a measurable difference between the eastern and western borders. There is no very important variation in the precipitation, the average rainfall for the region being about 45 inches.

DISTRIBUTION OF CROPS.

The distribution of crops is governed to a considerable degree by temperature variations, and is but slightly affected by the precipitation. Crops like corn, small grains, Irish potatoes, and tobacco will succeed throughout the province. Cotton is restricted to that portion lying to the south of a diagonal line extending from about the western-central boundary in North Carolina to the northern boundary of the Virginia-North Carolina line, about the point of contact of the Coastal Plain and Piedmont. A few winter apples, especially the Winesap, succeed along the western border from central Virginia to northern Georgia, while a number of varieties do well in the area from northern Virginia to New York. Timothy begins to thrive in northern Virginia, and buckwheat does quite well in the Pennsylvania-New Jersey portion of the province.

EFFECT OF CLIMATE ON EROSION.

The freezing of the soil to greater depths in the northern Piedmont undoubtedly has assisted in making the land here less susceptible to erosion than in the southern division. Freezing effects a more open structure, to the depth to which frost extends, with a consequent increase in the capacity of the soil to absorb the rainfall, thus reducing the run-off and its disastrous results. Also, the protracted winter freezes serve to hold the soil in place against winter erosion, while the more persistent growth of grass in the cooler northern latitudes helps to lessen the damage from summer rains.

SOILS OF THE SOUTHERN PIEDMONT.

The most important soils of the Southern Piedmont region in point of extent and agricultural importance are found in the Cecil series, which is extensively developed throughout the entire southern division. The next important group is represented by the Louisa series, the members of which have red and gray soils with red clay subsoils, like the Cecil, though differing from the latter in origin, in agricultural value, and in having a highly micaceous subsoil. The Cecil soils are derived chiefly from granites and gneisses, while the Louisa are derived from talcose and micaceous schists.

The members of these series, respectively, consist of essentially the same materials, mineralogically and chemically. The respective subsoils show marked similarity in character of material, the type classification being based upon differences in the texture of the relatively shallow surface soil.

Subordinate soils of the Southern Piedmont—subordinate both in extent and in general agricultural value—are derived from various igneous rocks giving more or less varied residual products. These, however, do not give rise to complete soil series, which can hardly be effected where the products of decay are so similar in their textural characteristics and where erosion has been probably the only important factor in modifying the mantle of decayed rock material.

The Iredell and Durham soils, while not nearly so extensive as the Cecil group, occupy a considerable area. The Iredell soils, derived largely from diorite, have yellowish-brown to grayish-yellow, very sticky subsoils of heavy intractable clay, while the Durham, derived from granites and gneiss, consisting largely of quartz and feldspar, have yellow, friable sandy clay subsoils. Texturally the subsoils of the Iredell and the related Mecklenburg series are the nearest Piedmont equivalents of the heavy, plastic clay subsoils of the Coastal Plain soils, typically represented by the Susquehanna series, while the Durham and the related Appling series, together with the Granville, are in characteristics of both the soils and subsoils nearest like the Norfolk soils.

The Iredell soils are widely distributed throughout the southern division of the province. Some of the most important areas are found in the vicinity of Chester, S. C.; Statesville, N. C.; and the region through Culpeper and Warrenton, Va. The Durham series is most prominently developed in Virginia and the Carolinas, while the related Appling soils, so far as mapped, hold a corresponding place in the eastern part of the South Carolina and Georgia Piedmont region.

Two rather extensively developed series are represented by the Alamance and Georgeville, the silt-loam members of which dominate the central portion of North Carolina, where the peculiar series of fine-grained slates known as the Carolina slates are responsible for these compact silt loams, having, respectively, gray and reddish soils and yellow and red silty clay subsoils.

SOILS OF THE NORTHERN PIEDMONT.

The northern extension of the Piedmont Plateau, which is comparatively narrow, is dominated by the Chester series, derived chiefly from gneiss, granite, and schist, and the Penn series, derived from the dark Indian-red sandstone, shale, and conglomerate of Triassic age (Newark).

The Chester series, characterized by its grayish or grayish-brown soils and yellow, moderately dense clay subsoils, is extensively developed in Pennsylvania, Maryland, and northern Virginia. In color these soils correspond to the Durham of the southern portion of the province, although there is a wide difference in texture. The Chester is derived largely from fine-grained rocks and in its typical development has clay subsoils with a relatively small sand content, whereas the Durham is chiefly from coarse-grained rocks, and has sandy clay subsoils of friable structure. The Chester soils are more productive than the Durham.

The Penn series is quite extensively developed in a nearly continuous belt from New York City to the vicinity of Orange, Va. It occupies the greater part of the province in New Jersey, is extensive in Pennsylvania, and of considerable importance in both Maryland and Virginia. Smaller bodies of the Penn and the related Granville occur over the scattered areas of Triassic rocks in the southern division of the province as far south as the vicinity of Wadesboro, N. C. The most important developments are the narrow interrupted belt in Campbell and Pittsylvania Counties, Va., Rockingham and Stokes Counties, N. C., and the wide belt extending from the neighborhood of Oxford, N. C., southwesterly to the South Carolina line near Wadesboro.

The Penn and Granville are the only important Piedmont soils derived from unmodified sedimentary rocks. In the Penn series the loams are the important types, while the sandy loams predominate in the Granville. The more important members of the Granville soils are derived from a coarser textured sandstone than the Penn types, and have doubtless undergone more complete weathering or have been influenced more through the elutriation processes of erosion. The Granville soils are very much like the Durham in color and textural characteristics. Both the Penn and Granville series include good agricultural soils.

Another northern Piedmont series has been given the name Manor. These soils have an especially important development in Pennsylvania. They are derived from schists and have a reddish clay subsoil with a greasy feel, and are closely related to the Louisa soils of the southern Piedmont. Agriculturally these soils are of medium value.

The Iredell series is not prominent in the northern division, its place being taken by the Montalto series, which resembles it in a few particulars.

A very large proportion of the northern Piedmont Plateau is occupied by loam soils, whereas the loam group in the southern division is of relatively little importance, at least in extent. This is largely accounted for by the prevailing finer textures of the northern Piedmont rocks, although a difference in the processes of erosion possibly has been a contributing factor.

There have been surveyed in the Piedmont Plateau Province, on the scale of 1 inch to a mile, 12,161,722 acres, and on a reconnoissance scale of 4 to 6 inches to a mile, 254,272 acres. Deducting 222,912 acres representing an overlap of the two surveys, the total area surveyed is 12,193,082 acres. Of this total an area of 12,015,834 acres has been mapped in sufficient detail to show the soil series and 11,984,474 acres in detail great enough to show the individual types. In addition to this there are 177,248 acres of miscellaneous material, which because of low agricultural value has not been differentiated on a type basis.

DESCRIPTION OF THE SOIL SERIES.

Alamance series.—The surface soils of this series are gray to almost white and of silty texture. The subsoils are composed of yellow rather compact silty clay. Scattered over the surface are fragments of the parent rocks which belong to the "Carolina slates," forming a belt in central North Carolina, and extending a short distance into South Carolina. These slates are usually quite fine grained and contain little mica. They differ in structural and mineralogical characteristics from the sericitic and micaceous schists giving rise to the York soils of the Piedmont, the Alamance soils being less micaceous and lacking the greasy feel of the York subsoils. The topography varies from nearly flat to rolling or in some places steeply rolling.

Area and distribution of the soils of the Alamance series.

Soil name.	State or area.[1]	Acres.
Alamance slate loam	North Carolina 3	5,824
silt loam	North Carolina 1, 3, 11, 17, 23; South Carolina 9	105,844
Total		111,668

[1] For key to numbers in this column, see p. 733.

Appling series.—The types of this series are characterized by the grayish to pale yellow color of the surface soils and the mottled or streaked red and yellow color of the subsoils. In places the yellow color varies from yellow to red in different situations, while grayish or drab colors are also occasionally noted in the subsoil. These soils are derived principally from schist of grayish color and undetermined composition, from hornblende schist, and from gneiss. Occasional small areas of the red Cecil material suggest that fields of this type belong in the Cecil series, requiring examination of the subsoil underlying the associated grayish soils to determine the character of the prevailing type. The topography averages about the same as that of the Cecil, possibly somewhat less rolling. The soils are fairly productive, although slightly inferior in this respect to the Cecil and corresponding more closely with the Durham. Their crop adaptation is also very close to that of the Durham. Oats, rye, corn, cotton, peanuts, forage crops, sweet potatoes, and other vegetables, and melons give the best results.

Area and distribution of the soils of the Appling series.

Soil name.	State or area.[1]	Acres.
Appling coarse sand	Georgia 5	320
sandy loam	Georgia 5; South Carolina 9	32,192
coarse sandy loam	Georgia 5	61,440
fine sandy loam	...do	4,224
silt loam	...do	4,288
Total		102,464

[1] For key to numbers in this column, see p. 733.

Cardiff series.—The Cardiff series is characterized by the yellowish-brown color of the soil, the yellow color of the subsoil, and by a substratum of slate. Fragments of the parent rock are of common occurrence throughout the soil section. These soils are most typically developed in the northern Piedmont near the Maryland-Pennsylvania line. Fair to good yields of corn, oats, wheat, and rye are obtained. Peaches and apples give good results.

Area and distribution of the soil of the Cardiff series.

Soil name.	State or area.[1]	Acres
Cardiff slate loam	Maryland 5; Pennsylvania 1	2,458

[1] For key to numbers in this column, see p. 733.

Cecil series.—The Cecil series includes the most important and widely distributed soils of the Piedmont Plateau. The heavier members are known as the "red-clay lands." These soils are characterized by their red clay subsoils and gray to red soils ranging in texture from sand to clay, the lighter colors prevailing in the sandy members. A characteristic of the subsoil is the content of sharp quartz sand and the frequent occurrence of veins of quartz. Mica flakes are also usually present in the subsoil. The soils are of residual origin and derived principally from granite and gneiss, weathered to great depths so that rock outcrops are rare. Fragments and bowlders of the parent rock are, however, found in places on the surface. The topography is rolling to hilly with level to undulating areas in situations where stream erosion has not been too active. The soils of the Cecil series are adapted to the general farm crops. In the South cotton is an important crop. Heavy export tobacco is also grown extensively.

Area and distribution of the soils of the Cecil series.

Soil name.	State or area.[1]	Acres.
Cecil sand	South Carolina 9	896
sandy loam	Alabama 7, 24, 33, 36; Georgia 4, 5, 6, 9, 12, 13, 14; North Carolina 3, 4, 5, 10, 11, 14, 15, 17, 22, 23, 26; South Carolina 1, 2, 3, 5, 9, 11, 13, 15, 17; Virginia 1, 2, 3, 6, 8, 11.	3,331,480
stony sandy loam	Alabama 7, 33, 36; Georgia 9; North Carolina 15; South Carolina 2.	202,048
coarse sandy loam	Georgia 5; North Carolina 3, 10, 15, 17; South Carolina 9, 15	124,352
fine sandy loam	Alabama 33; Georgia 5; North Carolina 3, 10, 11, 15, 17; South Carolina 9, 13.	191,552
very fine sandy loam	Georgia 5	4,736
loam	North Carolina 3, 10; South Carolina 15	190,208
stony loam	Alabama 7, 24, 33, 36; New Jersey 3; North Carolina 10; Pennsylvania 9, 10; South Carolina 3, 5.	239,273
gravelly loam	Georgia 12; North Carolina 23; South Carolina 9, 11	33,664
clay loam	Alabama 7, 33, 36; Georgia 5, 12; North Carolina 3, 10, 11, 15, 17; South Carolina 9.	566,272
clay	Alabama 24; Georgia 4, 6, 9, 13, 14; Maryland 3, 5, 7; North Carolina 1, 3, 4, 5, 10, 14, 17, 22, 23, 26; Pennsylvania 6; South Carolina 1, 2, 3, 5, 11, 13, 15, 17; Virginia 1, 2, 3, 4, 6, 7, 8, 11.	2,543,939
stony clay	Alabama 7, 24, 36; South Carolina 17	45,504
Total		7,473,924

[1] For key to numbers in this column, see p. 733.

Chester series.—The Chester series occurs in the northern part of the Piedmont Plateau, having been mapped only in Pennsylvania, Maryland, and Virginia. The types in this series differ from those of the Cecil series in having yellow or only slightly reddish yellow subsoils and gray or brown surface soils, the latter being, on the whole, lighter and more friable than the Cecil. The members of this series are prevalently more micaceous than the Cecil soils. Locally they are known as "gray lands" to distinguish them from the "red lands" of the Cecil series. The topography in general is not so rough as over Cecil areas, being rolling to moderately hilly. The soils, which are of residual origin, are derived from igneous and metamorphic rocks, principally gneiss, granite, and schist. Weathering has not reached to such great depth as in the case of the Cecil series, the underlying rock often being encountered within 2 feet of the surface on eroded slopes.

The soils are adapted to general farm crops, especially corn, and also to fruit and canning crops. Of the latter, tomatoes and sugar corn are the most important. The soils are not so strong as those of the Cecil series, requiring more careful treatment to maintain the yields.

Area and distribution of the soils of the Chester series.

Soil name.	State or area.[1]	Acres.
Chester sandy loam	Maryland 7; Virginia 7	27,968
fine sandy loam	Pennsylvania 6, 12	6,080
loam	Maryland 3, 5, 7; Pennsylvania 1, 3, 6, 12; Virginia 1, 7; West Virginia 3.	600,680
stony loam	Pennsylvania 3, 6	84,864
Total		719,592

[1] For key to numbers in this column, see p. 733.

Conowingo series.—The soils of the Conowingo series are grayish yellow to brownish and the subsoils yellowish. Some of the areas mapped have a red subsoil and possibly represent soils that should be separated from those having a yellow subsoil. The Conowingo soils are derived from serpentine and talcose rocks. Those areas derived from talcose material have a decidedly greasy subsoil and are locally known as "soapstone lands." The topography is in general rolling to hilly, although there are occasional poorly drained, flat areas locally known as "glades." A considerable portion of the clay member of this series is fairly well suited to the production of general farm crops. The "barrens" phase, which in places is very stony, with a hilly to broken topography, is generally unproductive and practically worthless for agricultural purposes.

Area and distribution of the soil of the Conowingo series.

Soil name.	State or area.[1]	Acres.
Conowingo clay	Maryland 3, 5; North Carolina 14; Pennsylvania 6; Virginia 1	49,894

[1] For key to numbers in this column, see p. 733.

Durham series.—The soils of the Durham series are characterized by the grayish color of the surface soils and the yellow color of the subsoil. They are derived from light-colored, rather coarse grained granite and gneiss, consisting principally of quartz and feldspar with some mica. The topography is generally gently rolling and the drainage thorough or in places excessive, owing to the sandy, porous texture of the subsoil. The soils are deficient in organic matter and require applications of manure or fertilizer in order to give good results.

Area and distribution of the soils of the Durham series.

Soil name.	State or area.[1]	Acres.
Durham coarse sand	Georgia 12	3,584
sandy loam	Alabama 33; Georgia 14; North Carolina 1, 3, 4, 11, 14, 15, 17, 22, 26; South Carolina 1, 2, 3, 5, 15, 17; Virginia 2, 6, 8, 11.	310,880
coarse sandy loam	Alabama 7, 36; North Carolina 3, 5, 10, 11, 15; South Carolina 15.	89,536
fine sandy loam	Alabama 33; North Carolina 11	25,408
Total		429,408

[1] For key to numbers in this column, see p. 733.

Edgemont series.—The Edgemont series has gray soils and yellowish colored subsoils. These soils occupy high ridges and isolated hills in the Piedmont region. They are derived mainly from quartz-schist, and quartzite. They are of low agricultural value and probably best suited to fruit growing and forestry.

Area and distribution of the soil of the Edgemont series.

Soil name.	State or area.[1]	Acres.
Edgemont silt loam	Georgia 13	2,240

[1] For key to number in this column, see p. 733.

Georgeville series.—The Georgeville types are characterized by the reddish-brown color and prevailingly silty character of the surface soils and by the red clay subsoils. Like the Alamance these soils are derived from the "slates" of the Carolina slate belt. It is believed that the rocks of this group giving rise to this series are higher in content of iron-bearing minerals than those giving rise to the Alamance. The topography varies from undulating to rolling or broken along stream slopes. The drainage is good. These are somewhat stronger agricultural soils than the corresponding members of the Alamance series.

Area and distribution of the soil of the Georgeville series.

Soil name.	State or area.[1]	Acres.
Georgeville silt loam	North Carolina 3, 11, 23; South Carolina 9.	102,656

[1] For key to numbers in this column, see p. 733.

Granville series.—The Granville series includes types of grayish colored surface soils and the yellow, friable, sandy clay subsoils. In the lower part of the subsoil the Indian red clay (Penn material) and a grayish clay of plastic structure are frequently encountered. In physical characteristics these soils are similar to the Durham types, but the subsoils are slightly more plastic and somewhat heavier. The deep subsoil or substratum also differs from that of the typical Durham in the variegated color, which frequently includes Indian red, greenish-gray, purplish, drab, and white.

The agricultural value of these soils is about the same as that of the Durham series. They are particularly adapted to bright or yellow tobacco, corn, peanuts, sweet or Irish potatoes, forage crops, and vegetables. Wheat and grass do not give as good results as on the Indian-red Penn soils. The parent rock of the series is Triassic sandstone. It is possible that the lighter color, as compared with the Penn soils, which are also derived from Triassic sandstone, is due to leaching processes. The topography varies from gently rolling to slightly hilly and the drainage is good.

Area and distribution of the soil of the Granville series.

Soil name.	State or area.[1]	Acres.
Granville coarse sandy loam	North Carolina 11, 23	46,400
fine sandy loam	North Carolina 23	3,776
gravelly loam	do	640
Total		50,816

[1] For key to numbers in this column, see p. 733.

Herndon series.—The types in the Herndon series have gray soils and red subsoils. They occupy high, isolated hills or ridges in the Piedmont region and are derived principally from quartzite and quartzite schist. They are of low agricultural value, being best suited to forestry. The better located areas can probably be used for fruit.

Area and distribution of the soil of the Herndon series.

Soil name.	State ar area.[1]	Acres.
Herndon stony loam	North Carolina 5	384

[1] For key to number in this column see, p. 733.

Iredell series.—The soils of the Iredell series are light-brown to almost black in color and frequently carry small iron concretions. The subsoils consist of extremely plastic, sticky, or waxy clay of a yellowish-brown to greenish-yellow color. Disintegrated rock is very often encountered within the 3-foot section. The topography varies from nearly flat to gently rolling. The parent rocks consist mainly of diorite, hornblende schist or hornblende gneiss, and chloritic rocks. The intractable subsoil in places lies near the surface, making cultivation difficult, but over the deeper areas having a soil lighter than a clay a very fair seed bed can be maintained. Soils of this series are best suited to small grain and grass. Under certain conditions corn and cotton do fairly well.

Area and distribution of the soils of the Iredell series.

Soil name.	State or area.[1]	Acres.
Iredell sandy loam	North Carolina 5; South Carolina 9	96,960
stony sandy loam	Alabama 36	3,840
coarse sandy loam	Georgia 5	3,456
fine sandy loam	Georgia 5; North Carolina 3, 11, 17; Virginia 4	45,312
loam	Alabama 33; North Carolina 3, 11, 17, 23	54,720
stony loam	Georgia 5; North Carolina 11	2,304
clay loam	Georgia 9; North Carolina 1, 10, 11, 26; South Carolina 1, 5, 9, 17; Virginia 2, 4, 7, 8, 11.	282,026
Total		488,618

[1] For key to numbers in this column, see p. 733.

Lansdale series.—The Lansdale series is characterized by the gray, drab, or brownish color of the soils and by the slaty gray to pale yellowish color of the subsoil. These soils occur in close association with the Penn series and are derived from metamorphosed, Triassic sandstone and shale prevailingly of grayish color. The metamorphism has resulted chiefly from the heat of the intrusive rocks with which the typical Lansdale soils are associated. The topography ranges from rolling to hilly, and the drainage is good. The agricultural value of these soils is somewhat lower than that of the corresponding members of the Penn series. Moderate yields of corn, oats, wheat, Irish potatoes, and hay are secured.

Area and distribution of the soils of the Lansdale series.

Soil name.	State or area.[1]	Acres.
Lansdale stony loam	Pennsylvania 3	3,648
silt loam	Pennsylvania 3, 6, 12; Virginia 7	108,288
Total		111,936

[1] For key to numbers in this column, see p. 733.

Louisa series.—The soils of this series are predominantly gray to light gray and the subsoils red. The material is derived from talcose and micaceous schists and imperfectly crystalline slates. The structure is unfavorable to the maintenance of good tilth, and the soils especially have a tendency to bake and check on drying. The members of this series are slightly less productive than the corresponding types of the Cecil series. They can, however, be improved, especially by fall plowing, the growing of legumes and winter cover crops, liming, and the incorporating of organic matter. They are best suited to general farm crops, such as corn, grain, forage crops, and cotton

Area and distribution of the soils of the Louisa series.

Soil name.	State or area.[1]	Acres.
Louisa sandy loam	Alabama 14	51,520
gravelly sandy loam	do	34,560
fine sandy loam	Alabama 33; South Carolina 1, 5; Virginia 4, 8	280,128
loam	Alabama 8, 33; North Carolina 26; Virginia 4, 8	371,370
slate loam	Alabama 7, 8, 33, 36	226,304
silt loam	South Carolina 5	48,384
clay loam	Alabama 33	56,192
Total		1,068,458

[1] For key to numbers in this column, see p. 733.

Manor series.—The Manor soils are characterized by their yellowish-brown to brown surface color and the yellow to yellowish-red or dull red color of the subsoils. This series is also high in mica in both soil and the subsoil. This constituent gives a greasy feel, particularly to the subsoil material. The soils of this series are derived from phyllites, including mica schist and chlorite schists. Fragments of these rocks are of common occurrence throughout the soil section, some areas being very stony.

The members of this series are confined to the northern Piedmont, where they occupy gently rolling to hilly areas. Properly handled, the better lying areas give good yields of oats, corn and wheat, Irish potatoes, and hay. These soils are locally known as "slate lands," "dark slate lands," and "white slate lands," the last two designations originating from local variations in the color of the surface soils.

Area and distribution of the soils of the Manor series.

Soil name.	State or area.[1]	Acres.
Manor loam	Maryland 3, 5, 7, 8; Pennsylvania 6, 9, 12; Virginia 7	166,514
stony loam	Pennsylvania 6, 9, 12	38,956
Total		205,470

[1] For key to numbers in this column, see p. 733.

Mecklenburg series.—The types of the Mecklenburg series have reddish-brown to red surface soils and yellowish-brown, stiff clay subsoils grading usually into disintegrated rock within the 3-foot section. The upper part of the subsoil frequently has somewhat the characteristics of the Iredell soils. The material forming the types of this series is derived from diorite, metagabbro, and similar rocks. In some places the soils appear to represent Iredell material in an advanced stage of weathering. The topography is gently rolling and the surface drainage good. The soils are productive, closely approximating in agricultural value the corresponding Cecil types. Cotton, corn, oats, wheat, and grass and forage crops give good results.

Area and distribution of the soils of the Mecklenburg series.

Soil name.	State or area.[1]	Acres.
Mecklenburg sandy loam	North Carolina 3	6,464
loam	North Carolina 17	5,824
clay loam	North Carolina 3, 17	24,960
Total		37,248

[1] For key to numbers in this column, see p. 733.

Molena series.—The surface soils of the Molena series are gray to reddish brown and the subsoils red. The types are developed over broad, dome-shaped hills with smooth slopes found near stream courses. The material appears to have been modified by the action of water. The drainage is good, and the soils are adapted to cotton, corn, forage crops, watermelons, and sweet potatoes.

Area and distribution of the soil of the Molena series.

Soil name.	State or area.[1]	Acres.
Molena sand	Georgia 13	5,888

[1] For key to number in this column, see p. 733.

Montalto series.—The Montalto soils occur in the northern Piedmont plain and are derived from the weathering of dikes of trap rock, being locally known as "ironstone soils." The surface colors are reddish brown or dull yellowish red, though tilled fields often present a rusty-brown appearance. The Montalto soils, as a whole, are difficult to till, and especial care must be taken to cultivate only under favorable conditions of moisture. In spots the soils have a tendency to stick to the moldboard. They are not especially desirable for general farming for the above reasons, but are productive when properly handled, being especially adapted to apple and peach production.

Area and distribution of the soils of the Montalto series.

Soil name.	State or area.[1]	Acres.
Montalto stony loam	Pennsylvania 1, 3, 12	25,472
clay loam	Pennsylvania 1, 12	45,376
undifferentiated	Pennsylvania 15	30,144
Total		100,992

[1] For key to numbers in this column, see p. 733.

Penn series.—The Penn series includes Indian-red soils derived through the processes of weathering from red sandstone and shales of Triassic age. Detached areas of these rock formations occur in shallow basins in the Piedmont Plateau from the vicinity of New York City to South Carolina. In productiveness and crop adaptation the Penn series may be considered as intermediate between the Hagerstown and Cecil soils. Corn, wheat, oats, potatoes, grass, apples, and peaches are produced on different types of the series in the more northern States. Tobacco is grown in Virginia and tobacco and cotton in the Carolinas.

Area and distribution of the soil of the Penn series.

Soil name.	State or area.[1]	Acres.
Penn sandy loam	New Jersey 3; Pennsylvania 1, 10; Virginia 1, 4	61,774
gravelly sandy loam	Pennsylvania 3	17,344
loam	Maryland 7; New Jersey 3; Pennsylvania 1, 3, 6, 10; Virginia 4, 7.	320,266
stony loam	New Jersey 3; Pennsylvania 3, 6, 10, 11; Virginia 7	77,704
gravelly loam	Maryland 7; Virginia 7	704
shale loam	Pennsylvania 1, 3	118,784
silt loam	North Carolina 23; Pennsylvania 12	65,088
clay loam	Pennsylvania 3	896
clay	Maryland 7; Virginia 1, 7	27,904
undifferentiated	Pennsylvania 15	1,216
Total		691,680

[1] For key to numbers in this column, see p. 733.

Worsham series.—The soils of the Worsham series are composed of light gray surface soils and yellowish or mottled yellow, gray, and red, plastic clay subsoils. They occur through the Piedmont region in comparatively small areas, in which, owing to the imperviousness of the subsoils, the drainage is poorly established. The parent rocks consist principally of granite, gneiss, and associated formations. The agricultural value is low.

Area and distribution of the soils of the Worsham series.

Soil name.	State or area.[1]	Acres.
Worsham sandy loam	Alabama 36; Virginia 11	10,952
coarse sandy loam	Georgia 13	15,040
Total		25,992

[1] For key to numbers in this column, see p. 733.

York series.—The types included in the York series are predominantly gray to light gray at the surface and have yellow subsoils. They are derived from talcose and micaceous schists and imperfectly crystalline slates. The texture and structure of the soil are unfavorable to the maintenance of good tilth, as the surface bakes and checks readily, making cultivation difficult. Crop yields are generally low and the soils are exceedingly difficult to improve.

Area and distribution of the soils of the York series.

Soil name.	State or area.[1]	Acres.
York sandy loam	Alabama 14	3,008
fine sandy loam	Alabama 33; South Carolina 11, 15, 17; Virginia 4	113,088
loam	Virginia 2, 4	4,032
stony loam	Alabama 8	2,496
silt loam	South Carolina 11, 17	111,424
Total		234,048

[1] For key to numbers in this column, see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The sands are of relatively little importance in the Piedmont Plateau, as they are of rare occurrence and occupy only a very small acreage. They are of loose, open structure, and require liberal additions of vegetable matter and rather heavy applications of manure to produce yields even approximating the ordinary yields on heavier classes of soils. They are best suited to the production of vegetables, potatoes, melons, cucumbers, and cowpeas. Only two series are represented, the Cecil and Molena of the southern Piedmont, both of which occupy only small areas.

Cecil sand.—The surface soil is a light-gray sand from 24 to 36 inches deep underlain by the characteristic red clay. The type is usually developed on slopes where sandy material has accumulated from above through colluvial action. The soil does not retain moisture well and crops often suffer during dry seasons. Some of the areas are cultivated but the yields are low. Only occasional small patches of this soil have been encountered in the survey.

Molena sand.—The soil is a gray to brown or reddish colored loamy, medium to rather fine sand in places sufficiently incoherent to be wind drifted. The subsoil varies from a loamy sand to medium sandy loam of yellowish-brown to yellowish-red, or in some places a deep, dark-red color. A deep red sandy clay is frequently encountered below 3 feet. The type occurs in a somewhat broken belt extending parallel with and some distance back from rivers in the Piedmont Plateau. It occupies broad, dome-shaped hills, the crests rising to a height of 200 feet above the streams. The origin of this soil is somewhat obscure, but it is probably derived from weathered crystalline rocks. The soils are easily cultivated but droughty. Low yields of a good quality of cotton are secured.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Molena sand	Georgia 13	5,888
Cecil sand	South Carolina 9	896
Total		6,784

[1] For key to numbers in this column, see p. 733.

COARSE SAND PHASE.

Like the sands, the coarse sands of the Piedmont are of small extent and low agricultural value. They are adapted to the same crops and require the same treatment as the sands, the principal difference being their somewhat lower agricultural value.

So far only small areas of the Appling and Durham soils have been mapped, no representative of the group having been encountered in the northern division of the province.

Appling coarse sand.—The soil to an average depth of 6 inches is a gray, coarse sand to loamy coarse sand. In texture the subsoil is about the same as the soil, but the color is slightly yellower. The parent rock is sometimes encountered within 18 inches of the surface, but usually the soil is 3 feet or more in depth.

Durham coarse sand.—The type consists of a coarse, light-gray, incoherent sand which becomes yellow at a depth of 7 to 9 inches and increases in loaminess with

depth until at 20 to 24 inches a yellowish sandy clay is encountered. The lower subsoil is predominantly yellow, although in some places of a reddish color. The type is derived from granites and gneisses. Both soil and subsoil contain varying amounts of quartz and other rock fragments. On account of its coarse texture and open structure, the type is decidedly droughty. Special crops, such as sweet potatoes, melons, and a number of early vegetables and peaches, do quite well, but only moderate yields of the general farm crops are secured.

Area and distribution of the coarse sand.

Soil name.	State or area.[1]	Acres.
Durham coarse sand	Georgia 12	3,584
Appling coarse sand	Georgia 5	320
Total		3,904

[1] For key to numbers in this column, see p. 733.

SANDY LOAM GROUP.

The sandy loams form the most important group of soils in the southern division of the Piedmont Plateau. The larger proportion of these soils occurs in areas where erosion has been of such character as to leave a covering of at least 6 or 8 inches of the light, sandy loam forming the general surface stratum of the region over the clay. These soils carry in the surface mantle the more thoroughly disintegrated and weathered remnants of the original clay mass. The coarser particles consist largely of quartz grains, which have been the more difficult for surface waters of low velocity to remove on account of the greater weight of the particles.

On the sandy loam soils a lighter type of farm equipment is adequate to maintain them in the highest state of efficiency than is necessary in case of the heavier groups. The sandy loams, together with the lighter phase, the coarse sandy loams, are the lightest soils of the region desirable for general farming. They are not well adapted to hay, nor are they nearly so well suited to wheat and oats, dairying, or stock raising as the heavier soils. Nevertheless, they are relatively better suited to general farming than are the corresponding types of the Coastal Plain, as the clay subsoil is much nearer the surface than in the sandy loam soils of the Coastal Plain. The sandy loams of the Piedmont are also naturally more productive than the average of the corresponding group in the Coastal Plain because of the shallower depth of the loose sandy surface portion and the more retentive nature of the denser clay subsoil.

Another apparent influence of the closeness of the clay subsoil to the surface is to minimize the harmful effects of drought. With a good supply of moisture as close to the surface as in most of the Piedmont subsoils, and with the control of evaporation made possible by the easily mulched and friable sandy surface material, crops do not suffer so severely in dry spells as they do on deeper sandy soils having more open sandy clay subsoils, such as occur in the Coastal Plain. It frequently happens that crops withstand the effects of drought upon the Piedmont sandy loams to much better advantage than on the clays, particularly where the latter are not kept in a good, pulverulent condition by careful cultivation.

The main crops on the sandy loams of the southern Piedmont are cotton, corn, and tobacco. These mature earlier and in general produce lighter yields than could be obtained from the corresponding heavier soils. There is a compensating advantage in that these crops can be produced with a less extensive farm equipment and with less labor. In the case of cotton particularly the variety should be carefully selected to maintain the best yields. The later maturing varieties are likely to be hastened to maturity to a measurable advantage as compared with the same varieties on the later clay loams and clays. Cowpeas, crimson clover, soy beans, and vetch are grown both as forage crops and for soil improvement. The production of these crops, especially in rotation with cotton, corn, and tobacco should be greatly extended throughout the entire region.

Of the special crops requiring more intensive cultivation, peaches are important. Care must be exercised in the selecting of sites of proper exposures, especially in the southern part of the area. There is also considerable opportunity for the production of vegetables to supply the local summer and fall demands of the large and growing cities of the South. Some apples can be produced to advantage for local markets over most of the area of the sandy loams. Certain varieties of winter apples, such as the

winesap, do fairly well near the western boundary from northern Georgia throughout the region northward to Maryland.

The sandy loams require frequent additions of organic matter for best results. This can be advantageously supplied by turning under green or partially cured crops. Rye, oats, cowpeas, vetch, and crimson clover are good crops for the purpose. Fall plowing should be practiced, especially where the surface soil is sufficiently shallow to permit the turning up of clay from beneath. Generally these soils should be occupied in winter by some cover crop such as rye, oats, or vetch, to check erosion and leaching. While barnyard manure is highly efficacious on these lands the supply is generally inadequate, and it has been necessary to use more or less commercial fertilizers in order to maintain good yields. The best results are had, particularly on the Cecil sandy loams, with brands containing relatively high percentages of nitrogenous and phosphatic materials. Potash salts do not seem to be as efficacious on this land as on the deeper, sandier soils, and on the Iredell sandy loam.

The Cecil sandy loam is by far the most important member of the group. As a matter of fact, it is the most extensive soil of the entire Piedmont region, occurring throughout the southern division of the province. It is adapted, in varying degrees, to the production of all crops suited to the latitude in which it is developed, except bright tobacco and certain grasses. Dark export tobacco does well on this type.

The Durham sandy loam occurs most extensively in Virginia, North Carolina, and South Carolina. This type is the nearest Piedmont equivalent of the Coastal Plain Norfolk sandy loam, and its crop adaptation is somewhat similar. Bright tobacco, peanuts, potatoes, melons, and a variety of vegetables give yields rather closely corresponding to those secured from the Norfolk sandy loam. This, together with the coarse sandy loam member of the series, is the best trucking soil of the region. General farm crops do not yield so heavily as in the case of some of the other sandy loams, particularly the Cecil.

The Appling sandy loam seems to take the place of the Durham in the eastern part of the Piedmont in South Carolina and Georgia. Its crop adaptation and agricultural value correspond quite closely with those of the Durham. Cotton and corn give slightly heavier yields than on the corresponding Durham type.

The Iredell sandy loam is distributed throughout the southern Piedmont. It is not adapted to the production of bright tobacco, but gives fairly good returns with the dark type, suitable for export and the manufacture of plug tobacco. It is adapted to about the same crops as the Cecil sandy loam, but may not yield so well, except under favorable seasonal conditions.

The Mecklenburg sandy loam is found associated with the Iredell sandy loam, particularly in North and South Carolina. It is suited to the same crops, but gives heavier yields. The Worsham sandy loam is of little importance. It is the poorest drained and least productive of the southern Piedmont soils.

In the northern Piedmont region the sandy loams are relatively of much less importance than in the southern division. The only important representatives are the members of the Penn and Chester series, which are not extensively developed. These are the best truck, vegetable, and small-fruit soils of the northern Piedmont, and the lightest desirable soils for general farm crops.

Appling sandy loam.—The soil to a depth of 6 to 8 inches consists of a gray sandy loam becoming pale yellow and slightly heavier in the lower portion. The subsoil is a heavy sandy loam or sandy clay, heavier and more plastic in the lower portion and mottled or streaked with various shades of red and yellow. The type occupies gently rolling to low hilly country. Cotton, corn, peanuts, oats, rye, sweet and Irish potatoes, forage crops, and a number of vegetables give good results with moderate fertilization, deep plowing, and the incorporation of organic matter.

Cecil sandy loam.—The soil is a sandy loam of a gray to grayish-brown or yellowish color about 6 to 10 inches deep. The subsoil is a red, brittle clay containing coarse sand, both soil and subsoil carrying fragments of quartz. There is usually considerable fragmental quartz on the surface. The type occupies the high rolling to smooth inter-stream plateau land of the Piedmont and is derived from granite, gneiss, and to a less extent, from other crystalline rocks. In Virginia it is used for both bright and dark shipping tobacco. This is the lightest soil of this region desirable for general farming purposes. It is successfully used for cotton, corn, oats, cowpeas, and a number of the other forage crops.

Chester sandy loam.—This type consists of a light-brown or gray sandy loam about 8 inches deep, underlain by a heavy, yellow loam or clay loam characterized in places by a high content of medium and coarse sand. The surface material is not a loose sandy loam, but has more the properties of a loam, containing, however, considerable quantities of coarse quartz fragments. The type occupies rolling to somewhat hilly areas, which are generally well drained, and is derived from the weathering of granite, gneiss, and coarse-textured schist, the rocks carrying a relatively large proportion of

feldspar. This is a good soil for corn, which yields from 40 to 50 bushels per acre. It is not sufficiently retentive of moisture for the best results with wheat, which produces only 10 to 15 bushels per acre. It is a fairly good soil for the grasses.

Durham sandy loam.—The soil is a medium, loamy sand or light sandy loam, underlain at a depth of 4 to 6 inches by pale-yellow sand extending to a depth of 12 to 22 inches. The subsoil is a yellow, grayish-yellow or yellowish-brown sandy clay. Angular quartz fragments occur throughout the soil mass in varying proportions, but rarely ever in sufficient amounts to interfere seriously with cultivation. The type is derived mainly from a light-colored, medium-grained granite. Gneiss and mica schists enter into its composition to a small extent. Along the boundary between the Piedmont and Coastal Plains regions it is sometimes difficult to distinguish between this and the Norfolk sandy loam, as frequently neither is typically developed in such localities. The absence of waterworn gravel or the presence of angular quartz fragments offers much assistance in establishing the identity of the Cecil sandy loam in such gradational regions. Owing to lack of organic matter the type is somewhat droughty. General farm crops, including cotton, corn, bright tobacco, and forage, are grown principally, with fairly good yields. Truck crops do well, especially sweet potatoes and melons.

Iredell sandy loam.—The type consists of a dark-gray to dull-brown medium loam, underlain at a depth of 6 to 10 inches by a yellowish light brown, sticky, impervious clay grading into soft disintegrated diorite, or similar rocks, at 24 to 30 inches. The type is derived mainly from diorite. The native timber growth consists of post, red, white, and black-jack oak, and cedar pine. The type is locally styled "blackjack land" or "beeswax land." It is suited to oats, wheat, grass, and corn, and can be used to advantage for stock raising. Under ordinary conditions tobacco does not do well.

Louisa sandy loam.—The soil consists of a grayish to slightly reddish sandy loam from 5 to 10 inches deep, carrying a moderate amount of quartz and micaceous schist fragments. The subsoil is a brittle, red clay having a greasy feel as the result of the presence of a considerable quantity of mica flakes. Fragments of quartz and micaceous schist are frequently encountered in the subsoil portion. The type occupies gently rolling to rolling country where the drainage is well established. Some of the steeper slopes, unless carefully managed, are likely to suffer from erosion. The soil is adapted to the general farm crops, such as cotton, corn, oats, cowpeas, and sorghum. Vegetables do fairly well, especially on the deeper phases. The yields range from fair to good, according to treatment. Generally they do not average as high with the same management as on the Cecil sandy loam. The soil is usually quite deficient in organic matter, but this condition can be corrected by growing and occasionally plowing under cowpeas, vetch, oats, or rye. Moderate applications of commercial fertilizers can be profitably made on most of the type.

Mecklenburg sandy loam.—The soil consists of a dark-brown to reddish-brown light loam to sandy loam, from 6 to 12 inches deep. The subsoil is a yellowish-brown to ocherous yellow, plastic and impervious, heavy clay underlain at depths varying from 20 to 36 inches by disintegrated diorite, micadiorite, gabbrodiorite, or metagabbro. Hardwoods, principally oak and hickory, constitute the chief growth of forested areas. Under ordinary methods of cultivation corn yields from 15 to 30 bushels per acre and oats from 15 to 40 bushels. Wheat, cowpeas, and soy beans do fairly well.

Penn sandy loam.—The soil is a sandy loam from 6 to 15 inches deep, underlain by Indian-red loam or clay loam. Sandstone and shale fragments usually form 5 to 20 per cent of the soil mass. The type is derived from Triassic red sandstone and shale. The topography varies from rolling to moderately hilly. The soil is easily tilled. Crops, though of good quality, give only light yields.

Worsham sandy loam.—The soil is a gray to white sandy loam, having an average depth of about 12 inches. The subsoil is a yellowish or nearly white, sticky sandy loam or loam to stiff, plastic, yellow clay, mottled with white. The type is of residual origin, being derived from granites, gneisses, and schists. The soil gives light yields of the general farm crops.

York sandy loam.—The soil is a gray to light yellowish brown sandy loam ranging from 6 to 10 inches in depth. The subsoil is a yellow, micaceous clay. Quartz and schist fragments are scattered over the surface and disseminated throughout the soil mass. The agricultural value is low, cotton, corn, cowpeas, and oats giving the best results. The soil is much in need of organic matter and requires liberal additions of complete commercial fertilizers before good yields can be obtained.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Cecil sandy loam	Alabama 7, 24, 33, 36; Georgia 4, 5, 6, 9, 12, 13, 14; North Carolina 3, 4, 5, 10, 11, 14, 15, 17, 22, 23, 26; South Carolina 1, 2, 3, 5, 9, 11, 13, 15, 17; Virginia 1, 2, 3, 6, 8, 11.	3,331,480
Durham sandy loam	Alabama 33; Georgia 14; North Carolina 1, 3, 4, 11, 14, 15, 17, 22, 26; South Carolina 1, 2, 3, 5, 15, 17; Virginia 2, 6, 8, 11.	310,880
Iredell sandy loam	North Carolina 5; South Carolina 9	96,960
Penn sandy loam	New Jersey 3; Pennsylvania 1, 10; Virginia 1, 4	61,774
Louisa sandy loam	Alabama 14	51,520
Appling sandy loam	Georgia 5; South Carolina 9	32,192
Chester sandy loam	Maryland 7; Virginia 7	27,968
Worsham sandy loam	Alabama 36; Virginia 11	10,952
Mecklenburg sandy loam	North Carolina 3	6,464
York sandy loam	Alabama 14	3,008
Total		3,933,198

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

The stony sandy loams are of little importance in point of extent and agricultural value. They are confined chiefly to areas of sloping and rolling topography where erosion has been fairly active. Both the unfavorable topography and the abundance of stone interfere with tillage operations. These soils can never be made to produce as well as the sandy loams. The representatives of the Cecil and Iredell series are the only types so far mapped.

Cecil stony sandy loam.—The soil is a gray to grayish-brown or reddish-brown sandy loam carrying angular rock fragments in sufficient quantity to interfere with cultivation. The subsoil varies from a red heavy sandy loam through red sandy clay to a brownish loamy material consisting of soft, partially decomposed rock, clay, and sand. The type sometimes includes variations, too small to separate, in the form of areas having a yellow subsoil. The soil is derived principally from granite, gneiss, and schist. Though mainly rolling to hilly, considerable areas are steeply broken. Only moderate yields of cotton and corn are secured. The type is best suited to fruit, pasturage, and forestry. Apples do well, and peaches frequently give good results. Bermuda grass will prove a valuable grass for this land.

Iredell stony sandy loam.—The surface soil is a brown to greenish-brown loamy sand to light sandy loam with a large content of fine gravel. The subsoil is a yellowish-brown, plastic, adhesive clay, usually having a greenish cast. The type is derived mainly from diorite. It is rather poorly drained and is locally styled "spouty" or "blue" land. Stones are abundant over the surface. Moderate yields of cotton and corn are obtained. Wheat and oats should do fairly well.

Area and distribution of the stony sandy loams.

Soil name.	State or area.[1]	Acres.
Cecil stony sandy loam	Alabama 7, 33, 36; Georgia 9; North Carolina 15; South Carolina 2.	202,048
Iredell stony sandy loam	Alabama 36	3,840
Total		205,888

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam class is inextensive, only two types, the Penn and Louisa, having been mapped. The former is derived from Triassic conglomerate; hence its gravelly character. The Louisa is formed from quartz and schist. It is doubtful if the gravelly sandy loams in the Piedmont should be considered as of any more importance than a phase of the sandy loam group.

Louisa gravelly sandy loam.—The surface soil consists of a gray to reddish sandy loam from 4 to 12 inches deep, containing considerable quantities of quartz and micaceous

schist fragments. The subsoil is a brittle, red micaceous clay having a greasy feel, and carrying fragments of quartz or schist. The type occupies broken or dissected areas, stream slopes, and rolling to hilly country. Drainage is good, the steeper slopes suffering from erosion owing to the rapid run-off of rain water. In many areas plowing is difficult owing to the resistance offered by the rock fragments. The type is adapted to the general farm crops, such as cotton, corn, oats, and cowpeas. The ordinary yields are light. Liberal additions of organic matter and complete commercial fertilizers are necessary for the production of moderate to good yields.

Penn gravelly sandy loam.—The soil consists of a reddish-brown to Indian-red gravelly sandy loam, about 10 inches deep. The subsoil is a heavy sandy loam, loam, or even clay loam which continues to a depth of 24 inches, below which a sandy clay is frequently encountered. Both soil and subsoil contain from 20 to 60 per cent of large and small quartz or red sandstone gravel, while fields often present a gray appearance due to surface accumulations of quartz fragments. The soil material is derived from conglomerates of Triassic age. The topography is rolling to hilly. The type is well drained and mostly under cultivation. General farming is the most common form of agriculture, although the soil is apt to be droughty and crops suffer from this cause.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Louisa gravelly sandy loam	Alabama 14	34,560
Penn gravelly sandy loam	Pennsylvania 3	17,344
Total		51,904

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loams are rather extensively developed throughout the southern Piedmont. They are adapted to the same crops, though giving somewhat lighter yields, and require about the same kind of tools and management as the sandy loams. Owing to the closeness of the usually dense clay subsoil to the surface this group does not differ as much from the sandy loams in agriculture as do the coarse sandy loams of the Coastal Plain, with their usually deeper surface soils and lighter textured subsoils, from the sandy loams of that province.

The coarse sandy loam members of the Appling, Cecil, Durham, and Iredell series occur in scattered areas associated with the sandy loams of these series. The Durham and Appling coarse sandy loams are about equal in importance to the sandy loam members of these series. The Worsham coarse sandy loam is of little importance. The Granville, derived from Triassic rocks, is similar to the Durham in both physical properties and crop value.

Appling coarse sandy loam.—The soil is a coarse sandy loam to light coarse sandy loam, 8 to 15 inches deep, gray in the upper portion and pale yellow below. The soil becomes slightly heavier with depth and finally passes into a yellow, heavy sandy clay which becomes abruptly heavier and more plastic with depth and shows mottling or streaks of red, gray, or drab. Quartz fragments are found in the surface and throughout the soil section. The topography is gently to moderately rolling. With deep plowing, frequent incorporation of vegetable matter, and liberal applications of commercial fertilizers, good yields of oats, rye, cotton, corn, peanuts, cowpeas, bur clover, crimson clover, sweet potatoes, watermelons, and a number of garden vegetables are secured.

Cecil coarse sandy loam.—The surface soil to a depth of 5 or 6 inches consists of a brownish-gray to brown coarse sandy loam. A considerable proportion of the sand ranges from very fine to medium in texture, but there is always present sufficient coarse quartz sand and fine angular quartz gravel or coarser fragments to impart a decidedly coarse texture to the soil. The subsoil is a compact, red clay, also carrying considerable coarse sand and fine gravel. Large rounded masses of granite-like glacial bowlders are frequently encountered in fields. The soil is derived from a gray coarse-grained granite. Cotton and corn are the principal crops grown, the yields being about the same as upon the Cecil sandy loam. Better results are obtained in seasons of more than average rainfall. Owing to the open structure of the soil crops are apt to suffer from lack of moisture during dry seasons.

Durham coarse sandy loam.—The soil is a coarse loamy sand or light sandy loam, from 5 to 12 inches deep. The subsoil is a stiff yellow clay containing more or less angular quartz grains and fragments. The type is residual in origin and derived mainly from coarse-grained granite. It is admirably adapted to bright tobacco and fairly well suited to the production of sweet potatoes, watermelons, and a number of garden vegetables, such as peas, cucumbers, string beans, and radishes.

Granville coarse sandy loam.—The surface soil consists of a grayish coarse sandy loam, which usually at a depth of about 5 inches becomes pale yellow in color and slightly heavier in texture. The subsoil is a pale yellow sandy clay sometimes mottled with gray and occasionally including, especially in the lower portion, some Indian-red plastic clay (Penn material). The physical characteristics of a section of the type are very similar to those of the Durham coarse sandy loam, except for the frequent occurrence of Indian-red and grayish colored clay in the lower portion of the subsoil or its substratum. The clay content of the subsoil is slightly higher and the material more plastic than in the case of the Durham coarse sandy loam. The substratum is usually variegated in color, showing patches of Indian-red, purple, green, gray, drab, and white. "Gall spots," representing areas from which the surface soil has been washed off, are of common occurrence. In such areas the surface material is usually a plastic clay of Indian-red or grayish color. The type is derived from Triassic sandstone. The topography is gently undulating to rolling or slightly hilly and the drainage good to excessive. The agricultural value is about the same as that of the Durham coarse sandy loam. Good yields of a fine grade of bright or yellow tobacco are obtained. Corn, oats, peanuts, sweet and Irish potatoes, forage crops, and a number of vegetables do well.

Iredell coarse sandy loam.—The soil is a grayish to brown or grayish-brown moderately coarse sandy loam, having an average depth of 8 inches. The subsoil is a dingy or greenish yellow, dense, plastic clay, usually underlain by decomposed rock within the 3-foot section. Iron concretions are numerous on the surface. The type is derived principally from diorite and hornblende or chlorite schist. The topography is mainly sloping and considerable areas are eroded and gullied. The agricultural value of the type is low and much of it is best used for pasturage.

Worsham coarse sandy loam.—The surface soil consists of a light-gray loamy coarse sand to coarse sandy loam, from 8 to 20 inches deep, becoming yellowish gray or pale yellow with depth. The material is coarse and incoherent in the surface few inches, but slightly sticky below. The subsoil is a pale yellow to white heavy coarse sandy loam resting at 30 inches upon an impervious plastic yellow sandy loam mottled with red or light shades of drab. The type is derived from igneous and metamorphic rocks, such as diorite, granite, and schist. The topography varies from gently sloping to flat or undulating. Owing to its imperfect drainage the soil is cold and late. Little of it is under cultivation, on account of the low average yields and difficulty of cultivation. Potash is required to prevent cotton rust. Lime should be used liberally and barnyard manure and green crops plowed under to build up the organic content.

Area and distribution of the coarse sandy loams.

Soil name.	State or area.[1]	Acres.
Cecil coarse sandy loam	Georgia 5; North Carolina 3, 10, 15, 17; South Carolina 9, 15.	124,352
Durham coarse sandy loam	Alabama 7, 36; North Carolina 3, 5, 10, 11, 15; South Carolina 15.	89,536
Appling coarse sandy loam	Georgia 5	61,440
Granville coarse sandy loam	North Carolina 11, 23	46,400
Worsham coarse sandy loam	Georgia 13	15,040
Iredell coarse sandy loam	Georgia 5	3,456
Total		340,224

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams of the Piedmont occupy a less important position than the sandy loams and coarse sandy loams, and occur in scattered areas in association with the former soils. The Louisa, York, and Cecil comprise the largest areas.

Of the soils embraced in this group, the Cecil, Louisa, Iredell, and York have dense clay subsoils. The crop value of the fine sandy loams of the Piedmont as compared with the coarse sandy loams of the same province is hardly the equivalent of the fine sandy loams of the Coastal Plain in their relation to the coarser sandy soils of that prov-

ince, the Coastal Plain soils having a friable sandy clay subsoil. The Piedmont soils are usually more silty than those of the Coastal Plain, the proximity of the dense clay subsoil to the surface favoring puddling during times of heavy precipitation and facilitating the natural tendency to crack and check during subsequent periods of dry weather. These features induce a condition of structure which makes cultivation practically impossible except under the most favorable conditions of moisture. The coarser sandy loams are more favored in this respect. A heavy farm equipment is necessary and yields are often lower than those secured from the corresponding types of the Coastal Plain. Crops are noticeably later in reaching maturity and the soils not generally well suited to the production of vegetables. The grasses and wheat give better average returns than on the coarser sandy loams. Where cotton is grown, the early maturing varieties should be selected. Lands of this type should be fall-plowed and receive liberal applications of organic manures.

The Durham, Granville, and Appling fine sandy loams are much more nearly related to the Coastal Plain soils, such as the Norfolk fine sandy loam, than the soils of the series just mentioned. They have about the same crop adaptation and value and require practically the same treatment. These are earlier types than the Piedmont soils, which have heavier clay subsoils, and are more easily kept in good structural condition by reason of the greater average depth of the soils and the lighter texture of the subsoils. Wheat and grass do not give as good returns as on the Piedmont fine sandy loams having dense clay subsoils and shallower surface soils, but the earlier maturing crops, especially vegetables, find this land better suited to their requirements.

The Chester fine sandy loam is the only representative of this group occurring in the northern Piedmont. Its subsoil, in the areas so far mapped, is sometimes decidedly sandy, thus departing from the typical characteristics of rather dense, brittle subsoils.

Appling fine sandy loam.—This soil consists of a light-gray fine sandy loam becoming slightly heavier and yellowish with depth. The subsoil is encountered at depths of 16 to 20 inches and ranges from a fine sandy clay in the upper portion to a rather heavy and in places plastic clay in the lower portion. The color of the subsoil is prevailingly yellow, streaked or mottled with red. The type occupies gently sloping areas, ridges, and low hills and has good drainage. With careful methods of farming the legumes, oats, rye, sweet and Irish potatoes, and a number of garden vegetables do well. The soil needs organic matter and moderate applications of fertilizer.

Cecil fine sandy loam.—The type consists of a light-gray fine sandy loam, becoming pale yellow and slightly more compact with depth, and underlain at 10 to 15 inches by a stiff, red clay showing traces of yellow in local areas. Quartz fragments are usually present in the soil, and veins and fragments of the same material occur in the subsoil. The type occupies undulating to rolling uplands and has good drainage. It has been formed chiefly by the weathering of schists and fine-grained gravel and gneiss. Cotton and corn are the principal crops, although the soil is also adapted to stone fruits and small grains. It produces a fine-textured tobacco. The timber growth consists of hickory, oak, and pine, with gum in the swales and depressions.

Chester fine sandy loam.—The surface soil consists of a brown to yellow fine sandy loam, about 10 inches deep, generally quite sandy on the lower slopes. The subsoil is a yellow, fine sandy loam to fine sand. It often contains considerable fragmentary rock and occasionally is distinctly micaceous. The type is derived from fine grained sandstone and schist. It occupies moderately to steeply rolling country and generally has good surface and under drainage. Where the topography is suitable, this soil is adapted to the production of early garden crops and potatoes.

Durham fine sandy loam.—The type consists of a gray to yellowish fine to medium sandy loam from 8 to 10 inches deep underlain by a friable, yellow, fine sandy clay. The topography varies from undulating to gently rolling and the drainage is good. The soil is derived principally from fine-grained granite and gneiss. It is well suited to bright tobacco, peanuts, sweet and Irish potatoes, garden peas, cowpeas, crimson clover, watermelons, and cantaloupes. Rye, corn, oats, and cotton give fair to good yields with fertilization.

Granville fine sandy loam.—The soil is a yellowish-gray porous fine sandy loam from 6 to 14 inches deep. The subsoil is a yellow, or mottled yellow and gray, friable fine sandy clay which in the lower portion is often mottled with yellow, yellowish red, and Indian-red. The parent Triassic sandstone is in many places encountered within the 3-foot section, often at a depth of about 30 inches. The type is adapted to the production of cotton, corn, forage crops, oats, rye, peanuts, melons, and vegetables.

Iredell fine sandy loam.—The soil consists of a moderately heavy and compact grayish fine sandy loam from 8 to 10 inches deep. The subsoil is a yellowish-brown to dirty-brown clay extremely adhesive and plastic. Iron concretions are conspicuous in the poorly drained situations. The type is derived from intrusive rocks, such as diorite and chloritic schists. Owing to its intractable structure, it is rather difficult to main-

tain in a good condition of tilth. Grass, oats, corn, and cotton are the principal crops and under favorable seasonal conditions fair yields are obtained.

Louisa fine sandy loam.—The soil is a light-gray fine sandy loam which usually at a shallow depth grades into pale yellow fine sandy loam of slightly more compact structure. This is underlain at 5 to 15 inches by a stiff red clay, which in places grades into partially decomposed schistose or slaty rocks at a depth of 3 feet. Quartz fragments and veins are of common occurrence. The type occupies gently rolling to rolling uplands and the drainage is good. It has been formed chiefly through the weathering of talcose and micaceous schist and imperfectly crystalline slates. Cotton, corn, tobacco, and forage crops are the leading crops. A fine-textured tobacco is produced on the lighter and deeper phases, while heavier bodied tobacco is obtained from areas where clay comes closer to the surface. Under ordinary methods the average yields are low. For best results liberal applications of organic manures are necessary.

York fine sandy loam.—The surface soil consists of a light-gray, fine sandy loam assuming a pale yellow color and more compact structure at a depth of 8 inches. At 12 to 15 inches it is underlain by a subsoil of compact yellow clay. Quartz fragments are of common occurrence on the surface and throughout the soil mass. The type is derived principally from metamorphic rocks, chiefly talcose and micaceous schists. It occupies gently rolling to hilly uplands and has good drainage. Cotton, corn, and forage are the usual crops. The yields are somewhat better than on the silt loam, although the average is low. To obtain best results organic manures should be applied in liberal quantities.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Louisa fine sandy loam	Alabama 33; South Carolina 1, 5; Virginia 4, 8	280,128
Cecil fine sandy loam	Alabama 33; Georgia 5; North Carolina 3, 10, 11, 15, 17; South Carolina 9, 13.	191,552
York fine sandy loam	Alabama 33; South Carolina 11, 15, 17; Virginia 4	113,088
Iredell fine sandy loam	Georgia 5; North Carolina 3, 11, 17; Virginia 4	45,312
Durham fine sandy loam	Alabama 33; North Carolina 11	25,408
Chester fine sandy loam	Pennsylvania 6, 12	6,080
Appling fine sandy loam	Georgia 5	4,224
Granville fine sandy loam	North Carolina 23	3,776
Total		669,568

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

The very fine sandy loams occupy relatively small areas in the southern Piedmont, the member of the Cecil series being the only type of this class so far mapped. As in the case of the fine sandy loams, the very fine sandy loams with heavy clay subsoils are apt to assume unfavorable structural conditions and to require intensive treatment for the production of good crops. Such soils are naturally later in maturing crops and are consequently better suited to grass and small grains and less suited to vegetables than the coarser sandy loams.

Cecil very fine sandy loam.—This type consists of a surface soil of grayish to grayish-brown or reddish-brown very fine sandy loam from 4 to 10 inches deep, underlain by the characteristic red clay subsoil of the series. The type is derived from fine-grained schist and gneiss. The topography is gently rolling to hilly. Cotton, corn, forage crops, and small grain produce good yields.

Area and distribution of the very fine sandy loam.

Soil name.	State or area.[1]	Acres.
Cecil very fine sandy loam	Georgia 5	4,736

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loam soils have a fairly extensive development in the southern Piedmont region, and in the northern division they constitute the most important group both in point of area and agricultural value. They form the medium class of general farming soils, being probably best suited for corn and oats, with wheat and hay as second choice. They are also good soils for grazing and summer fattening of cattle and for the type of dairying where pasture is largely used for summer and fall feeding. Grasses remain green to much better advantage throughout the summer and fall than on the lighter textured lands. Soils of loam texture can not be cultivated over as wide a range of moisture conditions as the lighter soils, although intensive cultivation is necessary for the maintenance of good tilth. As compared with the heavier soils they are more easily managed and can be improved by incorporating vegetable matter and adding moderate applications of lime. They do not require as heavy fertilization as the sandier types, although manures and commercial fertilizers can be used profitably.

The Cecil, Iredell, Louisa, Mecklenburg, and York loams are the southern Piedmont representatives of this group so far mapped. The Louisa is the most extensive type, but somewhat less productive than the other types, with the exception of the York.

The Chester loam is the most extensive soil in the northern division of the Piedmont. It is an excellent type for general farming and gives good returns with certain varieties of apples. The Penn loam also is extensively represented. It is likewise a very valuable soil for the general farm crops of the region. With proper treatment, including moderate applications of lime, alfalfa can be successfully produced on it. Next to this the Manor loam, a fair to good general farm crop soil, is the most important type.

Cecil loam.—The soil consists of a pale yellow to brownish or reddish-brown friable loam from 8 to 12 inches deep. The subsoil is a red clay. Varying quantities of quartz occur scattered over the surface and to a less extent throughout the soil section. The type is derived principally from gravel and gneiss and occupies level to gently rolling uplands. Drainage is generally well established. The type produces good yields of wheat, oats, and corn. It is easily tilled and responds readily to any system of soil improvement.

Chester loam.—The soil consists of a brown or brownish-yellowish loam, sometimes slightly sandy and containing some mica. It is underlain by a heavy yellow loam subsoil grading into clay loam, which in the lower depths becomes somewhat lighter in texture and more micaceous. The color in some areas is reddish-yellow or red. Fragments of quartz and other rocks are usually found on the surface and throughout the soil section. It is a residual soil derived largely from gneiss and mica schist, but other metamorphic and igneous rocks may also enter into its composition. The surface is rolling to hilly and the drainage is good. The soil is well adapted to general farming, but requires careful treatment on slopes, where it washes badly.

Iredell loam.—The soil is a light-brown heavy fine sandy loam to light loam from 4 to 8 inches deep. The subsoil is a yellowish-brown, impervious, waxy, sticky clay, which at 20 to 30 inches is underlain by disintegrated rock. Black iron concretions are abundant on the surface and throughout the soil mass. The topography is flat or undulating to gently rolling. Surface drainage is good, except in the more level areas, which need ditching. The impervious subsoil retards the proper circulation of moisture and air. Diorite is the most common parent rock. Oak, principally blackjack, cedar, and old-field pine are the predominating tree species. The type is highly prized for oats, cotton, wheat, corn, and grasses. It requires deep fall plowing to obtain the best possible tilth.

Louisa loam.—The soil consists of a gray to pale yellow friable loam, which at a depth of 5 to 8 inches grades into a pale yellow clay loam. This is underlain at a depth of about 12 inches by a rather stiff red clay, grading in places at 24 inches into soft partially decomposed rock. Quartz and schistose in varying quantities are found scattered over the surface and to a less extent mingled with the soil mass. The type is derived from talcose and micaceous schists and imperfectly crystalline slates. It occupies undulating to rolling uplands and is generally well drained. The soil is not easily maintained in good structural condition, as it is inclined to run together and bake. Crop yields are low under prevailing methods of cultivation, but the soil responds readily to any system of improvement. The crops usually grown are wheat, oats, corn, cotton, and heavy tobacco.

Manor loam.—The soil consists of a yellow or yellowish-brown heavy loam about 8 inches deep. The subsoil is a yellow or reddish-yellow heavy loam which grades into clay loam at a lower depth. Mica schist fragments occur in places throughout

the soil profile, while occasionally the lower portion of the subsoil consists largely of small mica particles, which render it feathery and fluffy. The material forming this type is derived from hydromica schists. The topography ranges from gently to moderately rolling, with occasional hilly areas. Drainage is well established and the steeply rolling areas somewhat eroded. This soil produces fair yields of general farm crops.

Mecklenburg loam.—The soil to a depth of about 6 or 8 inches is a reddish-brown to red loam or light loam. The subsoil is a yellowish-brown or ocherous-yellow, plastic, tenacious clay, becoming more friable at a depth of 24 to 30 inches, as the result of the presence of partially decomposed fragments of the parent rock. Disintegrated rock with little if any fine earth is usually encountered within the 3-foot section. In places the subsoil resembles that of the Iredell, giving a section having somewhat the appearance of Cecil material over Iredell. The topography is usually undulating to gently rolling and the surface drainage good. The characteristic timber growth consists of white, red, post and blackjack oak with considerable hickory and a sprinkling of cedar and pine. The type is well adapted to corn, cotton, oats, wheat, grass, and forage crops. Yields of 15 to 30 bushels of corn, 15 to 40 bushels of oats, and from ½ to 1 bale of cotton per acre are obtained.

Penn loam.—The soil is a dark Indian-red loam from 8 to 12 inches deep, underlain by an Indian-red clay loam. Both soil and subsoil occasionally contain from 5 to 20 per cent of sandstone fragments. The type is derived from fine-grained brown or red Triassic sandstone. The topography is gently rolling and the drainage is fair, but plowing in beds is generally practiced to assist the natural drainage agencies. The soil is considered almost equal in fertility to the associated limestone soils. Corn, oats, wheat, grass, clover, and alfalfa do well. Applications of lime improve the land, particularly where alfalfa is to be grown.

York loam.—The type consists of a grayish-yellow, compact loam to silty loam about 10 inches deep, underlain by a yellow clay loam or silty clay loam having a greasy feel. This in turn rests upon partially decomposed talcose and mica schist at depths ranging from 20 to 30 inches. Both soil and subsoil contain rock fragments of schist and quartz. The topography is rolling to hilly and the soil but poorly adapted to crops. It is best used for fruit.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Chester loam	Maryland 3, 5, 7; Pennsylvania 1, 3, 6, 7, 12; Virginia 1, 7; West Virginia 3.	600,680
Louisa loam	Alabama 8, 33; North Carolina 26; Virginia 4, 8	371,370
Penn loam	Maryland 7; New Jersey 3; Pennsylvania 1, 3, 6, 10; Virginia 4, 7.	320,266
Cecil loam	North Carolina 3, 10; South Carolina 15	190,208
Manor loam	Maryland 3, 5, 7, 8; Pennsylvania 6, 9, 12; Virginia 7	166,514
Iredell loam	Alabama 33; North Carolina 3, 11, 17, 23	54,720
Mecklenburg loam	North Carolina 17	5,824
York loam	Virginia 2, 4	4,032
Total		1,713,614

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony loam soils hold a fairly important position in both the southern and northern divisions of the Piedmont. They occupy rolling and eroded areas where both the topography and rock content interfere with cultivation. But for these features this group would in agricultural value, crop adaptation, and cultural requirements correspond quite closely with the loam types.

The Cecil, Iredell, and Herndon are the only representatives of the group so far mapped in the southern Piedmont Plateau. The Penn, Chester, and Manor are the important northern types.

Cecil stony loam.—The soil varies from a gray to grayish-brown sandy loam to brown or red loam with an average depth of 8 inches. This subsoil is a red clay loam or clay. From 30 to 60 per cent of the soil and subsoil is composed of stones and bowlders. This is a residual type derived principally from the weathering of granite, gneiss, and intrusive dikes of trap rock. The surface is usually hilly and broken. The soil is adapted to general farm crops, apples, and peaches. Yields are generally low, owing to the difficulty of cultivation caused by the stones and the unfavorable topography.

Chester stony loam.—The surface soil has an average depth of 10 inches, and consists of medium to heavy brown loam. The subsoil is a yellow or yellowish-red clay loam that usually grades into a stiff clay at depths ranging from 24 to 36 inches. Stone and bowlders are scattered over the surface and mixed with both soil and subsoil in quantities varying from 30 to 60 per cent. The type is derived mainly from the weathering of gneisses and schists, although a few areas are derived from granite. The type occurs in small irregular areas associated with the Chester loam. The topography varies from moderately rolling to hilly. The drainage is good. Much of this type is used as permanent pasture, though where the slopes are not too steep good crops are obtained. In normal seasons corn yields 50 bushels, oats 35 bushels, wheat 20 bushels, potatoes 120 bushels, and hay 1½ tons per acre.

Herndon stony loam.—The soil is a grayish to grayish-brown loam, carrying rock fragments in quantities ranging from 20 to 60 per cent of the soil mass. The subsoil is a reddish-yellow to yellow clay which also contains rock fragments. The type is of residual origin and derived mainly from quartzite and slates, though modified in some cases by diorite and schists. Where cultivated it is well adapted to fruit, especially peaches. The topography is rolling to hilly and the type for the most part is in forest.

Iredell stony loam.—The soil consists of 6 inches of a brown loam having a slight greenish cast. The subsoil is somewhat variable but prevailingly a yellowish-brown silty clay loam which passes abruptly into a plastic and sticky, reddish-yellow, heavy clay changing in color to greenish brown with depth and resting upon partially decomposed rock fragments at 24 inches. Fragments of greenish and grayish schistose rocks, diorite, and sometimes quartz, are scattered over the surface and disseminated through the soil in sufficient quantities to hinder cultivation. Rock outcrops are also of frequent occurrence. The type is derived from andesite, altered andesite, and diorite or similar rocks. Of the crops ordinarily grown, wheat, oats, and grass give the best results.

Landsdale stony loam.—The type consists of a drab, slate-colored, or gray silty clay loam or silt loam about 8 inches deep, underlain by a slate-colored or lighter gray heavy silty loam grading with depth into a silty clay loam. The surface is usually strewn with fragments of metamorphosed Triassic sandstone, from which the type is derived. Stones are abundant and bedrock may be encountered at a depth of 2 to 4 feet below the surface. The topography is rolling to hilly. Drainage is thorough and crops suffer from drought on much of the type. Corn, wheat, oats, rye, and grass are grown, but the yields are considerably lower than on the Landsdale silt loam.

Manor stony loam.—The soil to a depth of 8 to 10 inches consists of a clay loam or heavy loam containing large quantities of small rock fragments. The subsoil is a light-yellow or grayish loam to clay loam. The subsoil always contains a large proportion of small schist fragments which sometimes represent the entire subsoil section with only the interstitial spaces filled with soil. The type is derived principally from mica schists. The topography is hilly to mountainous. Where cultivation is practicable, the soil produces fair yields of the staple crops. Much of the type is in forest.

Montalto stony loam.—The soil is a reddish-brown, rusty, or light-brown heavy silty loam with an average depth of 8 inches. Ironstone fragments are found on the surface and throughout the soil in amounts ranging from 20 to 40 per cent of its mass. The subsoil consists of reddish-brown, yellowish-brown or dull-red, heavy gritty loam to clay loam, usually resting on bedrock at 2 to 6 feet. The subsoil contains numerous large and small rock fragments, often sufficient to prevent boring more than 15 inches below the surface. This is a strong soil, used largely for general farming. Corn averages 40 bushels per acre, wheat 18 bushels, oats 35 bushels, and hay 1¼ tons. The type is adapted to apples, peaches, and grapes.

Penn stony loam.—This type consists of a rather heavy Indian-red loam, 8 to 10 inches deep, containing from 30 to 60 per cent of red or brown sandstone fragments, with a subsoil of much the same character as the soil and extending to a great depth. This type is derived from a more siliceous or hardened phase of the Triassic sandstone. The topography is hilly to mountainous and the natural forest growth is largely of chestnut and oak. The type is well adapted to forestry and orcharding, and the more level areas, when the stones are removed, to general farm crops.

York stony loam.—This is a gray to pale yellow loam or sandy loam underlain by yellow silty clay. Fragments of schist and quartzite are abundant on the surface and to a less extent throughout the soil section. The agricultural value is low. Cotton, corn, and cowpeas are the crops usually grown.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Cecil stony loam	Alabama 7, 24, 33, 36; New Jersey 3; North Carolina 10; Pennsylvania 9, 10; South Carolina 3, 5.	239,273
Chester stony loam	Pennsylvania 3, 6	84,864
Penn stony loam	New Jersey 3; Pennsylvania 3, 6, 10, 11; Virginia 7	77,704
Manor stony loam	Pennsylvania 6, 9, 12	38,956
Montalto stony loam	Pennsylvania 1, 3, 12	25,472
Landsdale stony loam	Pennsylvania 3	3,648
York stony loam	Alabama 8	2,496
Iredell stony loam	Georgia 5; North Carolina 11	2,304
Herndon stony loam	North Carolina 5	384
Total		475,101

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam group in the southern Piedmont is represented by two types, the Cecil and Granville. These soils occupy rolling to high, broken areas where erosion has badly dissected the surface. The agricultural value of this soil is comparatively low on account of the rough topography, the difficulty in cultivation caused by the high content of gravel, and the fact that the soils are droughty.

The gravelly nature of the nothern representative of the group, the Penn gravelly loam, resulted partly or mainly from the presence of gravel in the parent rock—a Triassic conglomerate. Erosion is active on this type, owing to the uneven surface configuration.

Cecil gravelly loam.—The soil is a gray to grayish-brown sandy loam about 7 inches deep, carrying varying quantities of angular quartz and gneissic and granitic fragments, ranging in size from very small particles to pieces one-half inch in diameter. The subsoil is a heavy, micaceous, red loam or clay loam, containing considerable angular gravel. Outcrops of granite frequently appear. The type is derived from the disintegration of coarse-grained granites and represents a less complete weathering of the rocks than some of the other types of the Cecil soils. A characteristic feature of this type is a lack of tenacity in both soil and subsoil, as a result of which the land erodes and gullies extensively. It occupies high, broken uplands. Drainage is good. Cotton, corn, and cowpeas are the principal crops. Parts of the type are suited to the production of small fruits. The characteristic timber growth is hickory, shortleaf pine, and cedar.

Granville gravelly loam.—The soil to a depth of 6 to 8 inches consists of a gray to yellowish-gray fine sandy loam to loam, containing from 25 to 50 per cent of quartz fragments and gravel. The subsoil is a yellowish-brown to reddish, plastic clay mottled with yellowish gray and red. The surface is rolling to hilly and the drainage good. The soil is derived from Triassic sandstone and some granite. Cotton, corn, and oats are the best crops.

Penn gravelly loam.—The soil is a dark-red or brown sandy loam about 8 inches deep, containing 10 to 60 per cent of small, rounded, sandstone gravel. The subsoil is a dark Indian-red loam or clay loam. The type occupies high, rolling uplands and is derived generally from red Triassic standstone. Drainage is good, but the soil is inclined to erode badly. It produces fair yields of corn, wheat, vegetables, and small fruit.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Cecil gravelly loam	Georgia 12; North Carolina 23; South Carolina 9, 11	33,664
Penn gravelly loam	Maryland 7; Virginia 7	704
Granville gravelly loam	North Carolina 23	640
Total		35,008

[1] For key to numbers in this column see p. 733.

SLATE LOAM PHASE.

The slate loams have a fairly extensive development in the southern Piedmont Plateau. The group is represented only by the members of the Alamance and Louisa series, and the type will probably not be encountered in the other series, except possibly the York and Georgeville, for the reason that the slaty rocks are largely confined to these particular series. In crop adaptation, agricultural value, and requisite methods of treatment these soils are about equal to the loams, except for the rock content and rougher topography, a condition which is reflected in the lower yields as compared with the loam soils.

In the case of the Louisa type the rocks are more properly schist than slates, although they usually have a more or less slaty structure.

In the Northern Piedmont the slate loams are inextensive, the Cardiff being the only representative.

Alamance slate loam.—The soil consists of a gray to nearly white silt loam about 8 inches deep, having a gritty feel, owing to the presence of numerous small fragments of slate rock. In some places there is a thin layer of yellow silty clay subsoil, but usually the gray silt loam is underlain by the parent slate rock. Slate fragments up to an inch or more in diameter are present in the soil in sufficient quantities to interfere materially with cultivation. The topography varies from gently rolling to rolling and broken. Much of the type is forested with valuable timber of oak, pine, and hickory. Owing to the rolling topography, open structure, and proximity of the bed-rock to the surface, the drainage is usually excessive. The average yields are low, but the deeper areas of less slaty soil give moderate yields of cotton, wheat, corn, and oats. In favorable situations certain varieties of apples, pears, and peaches do well.

Cardiff slate loam.—The soil is a heavy yellowish-brown loam about 8 inches deep, underlain by heavy yellow silty clay to a depth of 3 feet or more. Both soil and subsoil contain from 15 to 40 per cent of partially decomposed slate fragments. The type occurs on prominent narrow ridges and is derived from the decomposition and breaking up of fine-grained slate. The presence of the slate fragments in the soil makes quite friable what would otherwise be a refractory clay. Much of the type is forested with oak, chestnut, and other hardwoods. This soil produces fair crops of corn, wheat, rye, oats, and grass.

Louisa slate loam.—The soil is a light-brown loam to silt loam carrying considerable quantities of schist, phyllite, and sandstone fragments. The subsoil is a dull-red clay loam to clay, also containing rock fragments. The material is derived from metamorphic rocks such as schists, phyllite, slabby sandstone, and imperfectly crystalline, rather schistose slate. Occasional areas having a yellowish subsoil have been included on account of their small size. The topography is rolling to hilly and broken. Fair yields of cotton, corn, and oats are made in wet years, but in dry seasons crops often suffer for lack of moisture. Certain varieties of apples do very well.

Area and distribution of the slate loams.

Soil name.	State or area.[1]	Acres.
Louisa slate loam	Alabama 7, 8, 33, 36	226,304
Alamance slate loam	North Carolina 3	5,824
Cardiff slate loam	Maryland 5; Pennsylvania 1	2,458
Total		234,586

[1] For key to numbers in this column see p. 733.

SHALE LOAM PHASE.

The shale loam class, or phase, is represented by a single type, the Penn shale loam, so far mapped only in Pennsylvania. In this soil shale fragments from the parent Triassic rock are found in amounts sufficient to offer some hindrance to cultivation; otherwise the agricultural value of the soil is about the same as that of the loams.

Penn shale loam.—The soil is a dark Indian-red loam about 8 inches deep. The subsoil consists of a heavy clay loam the same color as the surface soil, grading into clay, and is of variable depth, always resting upon the shale rock from which it is derived. From 10 to 40 per cent of shale fragments occur in the surface soil, giving it the local name of "red gravel land." The quantity of such coarse material is always greater in the subsoil than in the soil. The drainage features of the type depend upon its topography, as the underlying beds of shale prevent the downward percolation of

water to any great depth. This type is derived from the underlying beds of shale, except on the lower slopes and hollows, where the soil contains varying quantities of material washed from higher elevations. It usually occurs as broad, rolling valley land, with surface features sometimes sharply broken. The soil is adapted to wheat, oats, corn, and hay.

Area and distribution of the shale loam.

Soil name.	State or area.[1]	Acres.
Penn shale loam	Pennsylvania 1, 3	118,784

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loams, which owe their textural characteristics chiefly to the nature of the fine-grained parent rocks, approximate the type of soils which may be designated as heavy farming land. More labor is required to keep them in a good condition of tilth than in the case of the sandy loams and loams, and heavier teams must be used. Wheat and hay come in as crops of nearly first rank, although corn is still an important field crop. Grass is of more importance for grazing than for hay, particularly in the southern Piedmont.

Deep fall plowing, the incorporation of vegetable matter, applications of lime, and frequent tillage are necessary for the maintenance of a proper structural condition for best plant development. If plowed when wet or grazed when in a miry condition the soils bake, and in subsequent cultivation clod badly. They therefore can not be pastured over as wide a range of moisture conditions as the loams. Less manure and fertilizer is required than on the sandy loams, although applications of fertilizers, particularly of phosphoric acid, can be used profitably. These soils are so late and cold natured that vegetables can not be grown on any extensive commercial scale. Early varieties, particularly of cotton, should be selected for this land. Applications of phosphatic fertilizers are advisable, especially to hasten the maturity of cotton.

The Alamance and Georgeville silt loams are the most extensive soils in central North Carolina, and adjacent portions of South Carolina where the parent rocks, the "Carolina slates," occur. The Appling and Louisa silt loams have a scattering development.

The silt loam type is probably the most extensive representative of the York series, in which it constitutes a late soil of low agricultural value.

The Lansdale and Penn silt loams are the northern representatives. Both are good general farming soils, while the latter can be successfully used for alfalfa.

Alamance silt loam.—The soil is a yellowish-gray to white floury but rather compact silt loam from 6 to 8 inches deep. The subsoil is a pale yellow heavy silt loam which quickly grades into a rather compact yellow silty clay. Fragments of the parent rock are found over the surface, sometimes in sufficient abundance to develop patches of slate loam. The greasy feel frequently noticed in the subsoil of the York series is absent in this type. The topography is flat to rolling. White oak, post oak, blackjack oak, and pine constitute the principal forest growth. The soil is low in organic matter and is inclined to run together and puddle in wet weather. It is considered an excellent grain soil, and when properly supplied with vegetable matter and moderately fertilized good yields of corn, cotton, and forage crops are obtained.

Appling silt loam.—The soil consists of a silt loam about 11 inches deep carrying an appreciable proportion of very fine sand and varying in color from gray, or gray with a slight reddish cast in the surface portion, to yellowish-gray or reddish-yellow below. The subsoil is a fine sandy to rather stiff silty clay of a dull-red to a deep-red color, mottled or streaked with lighter shades of red and yellow. Small fragments of the parent rocks, which consist principally of chlorite schists, are found on the surface and throughout the soil, and the partially decomposed bedrock is in many places encountered at 20 to 30 inches below the surface. The type is often called locally "slaty land." The topography varies from smooth to rather broken. Fair to good yields of corn, cotton, and oats are obtained with light applications of commercial fertilizers.

Edgemont silt loam.—The soil to a depth of 6 or 8 inches consists of a drab or dull-gray to yellowish-gray floury silt loam. The subsoil is a pale yellow compact silt loam, becoming heavier with depth and grading usually at a depth of 30 inches into

reddish silty clay loam or silty clay. Rock fragments occur on the surface, sometimes in sufficient amounts to interfere with cultivation and generally in varying amounts throughout both soil and subsoil. The soil material is derived principally from quartzite and quartz schist. The type occupies the crests and upper slopes of high monadnock hills and peaks. The surface configuration permits of ready surface drainage, though the soil itself becomes more or less soggy during wet seasons, owing to the impervious nature of the subsoil. This is a cold-natured soil, though subject to excessive surface loss of moisture during dry weather. Very little of the type is under cultivation, although certain varieties of fruits should do well. Deep plowing and applications of lime and organic matter are needed on this soil.

Georgeville silt loam.—The soil is a reddish-brown, rather heavy silt loam from 4 to 8 inches deep. The forested areas are grayish in the immediate surface portion and rather compact in structure. The subsoil is a red heavy clay, underlain at a depth of 36 inches by partially decomposed rock, which in turn rests upon bedrocks, closely related to those giving rise to the Alamance soils. The reddish color is believed to be due to the higher content of ferruginous minerals in the former rocks. The topography is undulating and broken along stream courses. The forest growth consists principally of oak, hickory, dogwood, and pine. This is a better agricultural soil than the Alamance silt loam, being well suited to oats, wheat, corn, and forage crops. Cotton is slow in maturing and the late bolls are sometimes killed by frost.

Lansdale silt loam.—The soil consists of a brown or slate-colored medium to heavy silt loam from 10 to 14 inches deep. The subsoil to a depth of 36 inches or more consists of a silty clay loam or heavy silty loam, grading into silty clay loam at an average depth of 20 inches. The subsoil ranges from pale yellow to yellowish gray in color and is generally lighter than the surface soil. The soil material is derived from fine-grained sandstones and shales of the Mesozoic age. The surface ranges from gently to moderately rolling and the drainage is adequate. This type is adapted to the production of general farm crops. Corn gives an average yield of 50 bushels; oats, 35 bushels; wheat, 20 bushels; rye, 25 bushels; hay, 1¾ tons; and potatoes, 135 bushels per acre.

Louisa silt loam.—The soil is a yellowish-gray to nearly white, compact silt loam about 8 inches deep. This grades through compact red silt loam into the subsoil proper—a stiff red silty clay—at a depth of about 14 inches. Quartz fragments are of common occurrence on the surface and throughout the soil. The soil is rather refractory and inclined to bake and crack, making plowing difficult except under favorable moisture conditions. The material is derived from fine-grained imperfectly crystalline metamorphic rocks, consisting chiefly of talcose and micaceous schists. The type occupies nearly level to rolling uplands and is ordinarily well drained. It is used principally for cotton, corn, and grain, the yields being poor.

Penn silt loam.—The soil consists of reddish to reddish-brown silt loam from 8 to 12 inches deep. The subsoil is an Indian-red or light-brown silt loam somewhat heavier than the soil and grading usually into a red silty clay in its lower depths. Both soil and subsoil contain from 5 to 15 per cent of shale and sandstone fragments. The type is derived from sandstone of Triassic age. The surface ranges from slightly to steeply rolling. Drainage over most of the type is very good, but on slopes where the bedrock lies near the surface seepy tracts are often encountered. This soil is adapted to the general farm crops, of which corn will average 50 bushels, oats 30 bushels, wheat 20 bushels, and hay 1¼ tons per acre.

York silt loam.—The soil is a light-gray to nearly white compact silt loam, resting at a depth of 8 inches upon a yellow, slightly heavier silt loam, which in turn is underlain at a depth of 10 to 15 inches by stiff yellow silty clay. Quartz fragments are of frequent occurrence on the surface and throughout the soil mass. The type is derived from imperfectly crystalline metamorphic rocks consisting principally of talcose and micaceous schists. It occupies undulating to gently rolling uplands and is usually well drained. It is locally known as "blackjack" land or "white" land. It bakes readily and is very difficult to maintain in good structural condition. Cotton and corn are the principal crops, the yields being poor.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
York silt loam	South Carolina 11, 17	111,424
Landsdale silt loam	Pennsylvania 3, 6, 12; Virginia 7	108,288
Alamance silt loam	North Carolina 1, 3, 11, 17, 23; South Carolina 9	105,844
Georgeville silt loam	North Carolina 3, 11, 23; South Carolina 9	102,656
Penn silt loam	North Carolina 23; Pennsylvania 12	65,088
Louisa silt loam	South Carolina 5	48,384
Appling silt loam	Georgia 5	4,288
Edgemont silt loam	Georgia 13	2,240
Total		548,212

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

The clay loams occupy a large area in the southern Piedmont region. They are found associated with the lighter members of the prominent series, and represent areas from which the coarser particles have been swept away by erosion. In these soils erosion has not advanced as far, however, as in case of the clays. Cultural operations are restricted to a narrower range in moisture conditions on clay loam lands than on any of the lighter textured soils. Grazing and plowing when the soil is in a sticky condition are invariably followed on drying out by a hardened structure favorable to rapid loss of capillary moisture through surface evaporation and to the formation of intractable clods. More labor and heavier teams are required for the maintenance of a good pulverulent structure, and heavier applications of lime can be used profitably. Fall plowing, where the land is seeded to winter cover crops, is commendable on all the clay loams.

These soils, in the southern division, are best suited to the production of cotton, corn, wheat, grass, and cowpeas for hay, and in case of certain series, of dark export tobacco. Apples of relatively good keeping quality are produced over the type in northern Georgia, over western developments in the Carolinas and southern Virginia, and over most of the province to the north. Vegetables, with the exception of a few such crops as lima beans, give poor results. The clay loams require less fertilization and are heavier producers than the lighter soils. Nevertheless, phosphatic and nitrogenous mixtures in moderate applications are beneficial.

The Cecil, Iredell, Louisa, and Mecklenburg clay loams are of common occurrence on the moderately rolling and sloping areas of the southern Piedmont. They are frequently developed in such small patches in association with the sandy loams that it is difficult to separate them from the associated soils on maps of the scale used.

The Montalto clay loam has a fairly extensive development in scattered areas over the northern Piedmont, particularly in Pennsylvania. A little of the Penn clay loam has been mapped in this division.

Cecil clay loam.—The surface soil is a reddish-brown or light-brown loam to clay loam from 6 to 12 inches deep. The first 2 or 3 inches may be somewhat sandy over small patches. The subsoil becomes heavier with depth, passing from a red clay loam into heavy red clay at an average depth of about 24 inches. Fragments of quartz and of the parent rock, granite or gneiss, are sometimes scattered over the surface in small quantities. The topography is moderately to rather steeply rolling. The soil absorbs moisture well and is not so susceptible to erosion as some of the more rolling and less absorptive members of the Cecil series. It is well adapted to wheat, oats, corn, export tobacco, early maturing varieties of cotton, and forage crops.

Iredell clay loam.—The soil is a dark-brown loam about 8 inches deep, carrying small, rounded iron concretions on the surface. The subsoil is a stiff, impervious, yellowish clay, underlain by soft decomposed rock. The type occupies level or slightly rolling areas, and is of residual origin, being derived from diorite and similar intrusive rocks. It is locally known as "blackjack" or "beeswax" land, the latter term being suggested by the character of the subsoil. Level areas are inclined to be swampy on account of the impervious nature of the clay subsoil. The type is considered a fair cotton, corn, and wheat soil. Grass does well.

Louisa clay loam.—The type consists of a reddish-brown clay loam to sandy clay loam from 3 to 6 inches deep, underlain by a red clay which usually extends to a depth of 3 feet. In some places, however, the parent schist rock is encountered within the 3-foot section. The subsoil has a characteristic greasy feel, owing to the presence of

particles of mica. Cotton, corn, small grains, and forage crops give fair to good yields particularly where the bedrock is not encountered within 3 feet of the surface. Crops suffer considerably during dry spells on those areas in which the rock lies at less depth.

Mecklenburg clay loam.—The soil to an average depth of 8 inches is a reddish-brown to red loam to clay loam. The subsoil is yellowish-brown or ocherous-yellow stiff plastic clay. At 18 to 24 inches the partially decomposed parent rock is encountered. Iron concretions occasionally occur on the surface. The topography varies from undulating to gently rolling or sometimes slightly broken along stream slopes. Surface drainage is usually good, except on some of the more nearly level areas. These can be effectively drained by open ditches. White, post, red, and blackjack oak, with hickory, pine, and cedar, constitute the usual forest growth. Cotton yields from one-half to 1 bale per acre, corn from 20 to 40 bushels, oats about the same, and wheat from 12 to 20 bushels per acre. The large yields are made under careful methods of soil management. Clovers, vetches, soy beans, cowpeas, and Johnson grass do well.

Montalto silt loam.—The soil consists of a light-brown to brownish-red clay loam averaging from 8 to 10 inches in depth. The subsoil is a yellowish-brown to yellowish-red clay, which sometimes carries a considerable amount of small gravel from the parent rock. The type is derived chiefly from trap rocks. It occupies rolling to hilly uplands, sometimes occurring in narrow strips following the line of the intrusive dikes from which it is derived. The drainage is good, the run-off in places being so rapid as to cause excessive erosion. Corn, wheat, oats, and hay are the principal crops. Under ordinary methods corn yields from 30 to 40 bushels, wheat 15 bushels, oats 30 bushels, and hay 1½ tons per acre.

Penn clay loam.—The surface soil consists of a brownish-red material, ranging from heavy loam or silt loam to a clay loam or even clay, with an average depth of 8 inches. In its typical development the soil material is a distinct clay loam. The subsoil to a depth of 36 inches is a dark Indian-red clay of a very plastic structure and distinctly greasy feel. This type has been formed by the decomposition of Triassic shale, fragments of which are occasionally found on the surface. The topography is rolling to hilly. It is somewhat harder to handle than the Penn loam, because of its heavier texture and closer structure, but is more resistant to drought and consequently produces better crops in dry seasons. It is adapted to the general farm crops. Alfalfa can be grown by liming the land.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Cecil clay loam	Alabama 7, 33, 36; Georgia 5, 12; North Carolina 3, 10, 11, 15, 17; South Carolina 9.	566,272
Iredell clay loam	Georgia 9; North Carolina 1, 10, 11, 26; South Carolina 1, 5, 9, 17; Virginia 2, 4, 7, 8, 11.	282,026
Louisa clay loam	Alabama 33	56,192
Montalto clay loam	Pennsylvania 1, 12	45,376
Mecklenburg clay loam	North Carolina 3, 17	24,960
Penn clay loam	Pennsylvania 3	896
Total		975,722

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The clay soils occupy a prominent position in the southern Piedmont, being developed extensively in the more rolling areas and on the steeper slopes where erosion has been sufficiently active to prevent the accumulation of a superficial layer of light-textured material. Some areas derived from the finer-textured rocks have probably never had a surface covering of coarse material, but the large proportion of the type represents land where a sandy mantle has previously existed. The "gall spots" found in the fields, which have been denuded of the sandy surface soil since the land has been brought under cultivation, illustrate the process involved in the formation of much of the class.

The clays are the heaviest soils and the most difficult to work and keep in good tilth, but when properly handled they give the best average yields of the general farm crops, especially of small grains and hay. Clover does well, and forage crops for curing or for ensilage give very large yields, so that the most intensive form of dairying, where pasturage is not necessary but where the cows are fed throughout the year for large milk and butter production, can be practiced. The limits of cultivation are restricted

to a very narrow range by the stickiness of the soil when wet, and its hardened, compact condition when dry. Grazing is particularly apt to produce unfavorable structural conditions, so that stock should not be permitted to roam over these lands when wet. By plowing when in a moderately moist condition and following with repeated harrowing a favorable tilth can be worked up. To maintain this condition the soil should be limed heavily and subsequently cultivated frequently when in just the proper moisture condition. In a hardened condition moisture is rapidly evaporated at the surface and crops suffer severely from drought unless a loose surface mulch is maintained during dry periods. Owing to the difficulty of keeping such a mulch, crops suffer more from drought on the clay lands than on the sandy soils. Freshly eroded areas in which the raw unweathered clay is exposed are generally intractable and very unproductive. Liberal additions of lime and vegetable matter, and a gradual deepening of the plowed section are the most essential requisites for the improvement of such land.

The Cecil clay is the only member of the group so far encountered in the southern division. It is developed in patchy and extensive areas throughout the southern division of the province. The Conowingo and Penn clay are the only northern types mapped in this group to the present time.

Cecil clay.—The surface soil is a reddish clay loam to clay from 2 to 6 inches deep underlain by a brittle, heavy red clay subsoil. Both soil and subsoil contain fragments of quartz and partially decomposed rocks. The type occupies high rolling land and is derived from granite, gneiss, gabbro, and other crystalline rocks. It is recognized as the strongest soil of the Piedmont plateau for general farming. It is adapted to grass, wheat, and corn in Maryland and Pennsylvania; export tobacco and wheat in Virginia; and to corn, wheat, and cotton in the Carolinas. The freshly eroded areas are usually of low agricultural value, requiring liberal additions of vegetable matter and lime before they become productive.

Conowingo clay.—This type consists of a yellow or reddish-brown loam surface soil about 8 inches deep, underlain by a yellowish-red to red clay or clay loam subsoil. Decomposed fragments of steatite give a greasy feel to the subsoil. Occasionally rock fragments occur on the surface, representing at times as high as 25 per cent of the soil mass. The type is derived from decomposed serpentine, steatite, talc schist, and similar rocks. It occupies rolling lands in the Piedmont Plateau. The type is fairly productive for the general farm crops, comparing favorably with the Cecil clay and Cecil loam. It is known in Maryland as "productive serpentine land."

Penn clay.—The soil is a dark Indian-red to dark reddish brown clay about 8 inches deep. The subsoil is a dark Indian-red clay, becoming stiffer in structure with depth. The type occurs in gently rolling uplands as a series of low ridges. The drainage is good. The material is of residual origin from red Triassic sandstone and shale. Wheat, corn, and grass are the principal crops.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Cecil clay	Alabama 24; Georgia 4, 6, 9, 13, 14; Maryland 3, 5, 7; North Carolina 1, 3, 4, 5, 10, 14, 17, 22, 23, 26; Pennsylvania 6; South Carolina 1, 2, 3, 5, 11, 13, 15, 17; Virginia 1, 2, 3, 4, 6, 7, 8, 11.	2,543,939
Conowingo clay	Maryland 3, 5; North Carolina 14; Pennsylvania 6; Virginia 1	49,894
Penn clay	Maryland 7; Virginia 1, 7	27,904
Total		2,621,737

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

The stony clay class, like the clay, has only one representative in the southern Piedmont—the Cecil stony clay. This soil occupies slopes and hills where the close pace kept upon rock weathering by erosion has brought about the stony character. The abundance of stone and unfavorable topography account for the lower agricultural value as compared with the clay type.

Cecil stony clay.—The soil consists of a heavy red loam or clay about 8 inches deep, underlain by a stiff red clay. Rock fragments and bowlders are scattered upon the surface and throughout the soil section, representing 30 to 60 per cent of the soil mass. The type occurs on rolling and hilly areas in the Piedmont Plateau. It is of residual origin, being derived from igneous and metamorphic rocks. It is generally too steep

and stony for cultivation and best suited for use as pasture and forest lands. The smoother areas give good yields of cotton, corn, and cowpeas.

Area and distribution of the stony clay.

Soil name.	State or area.[1]	Acres.
Cecil stony clay	Alabama 7, 24, 36; South Carolina 17	45,504

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

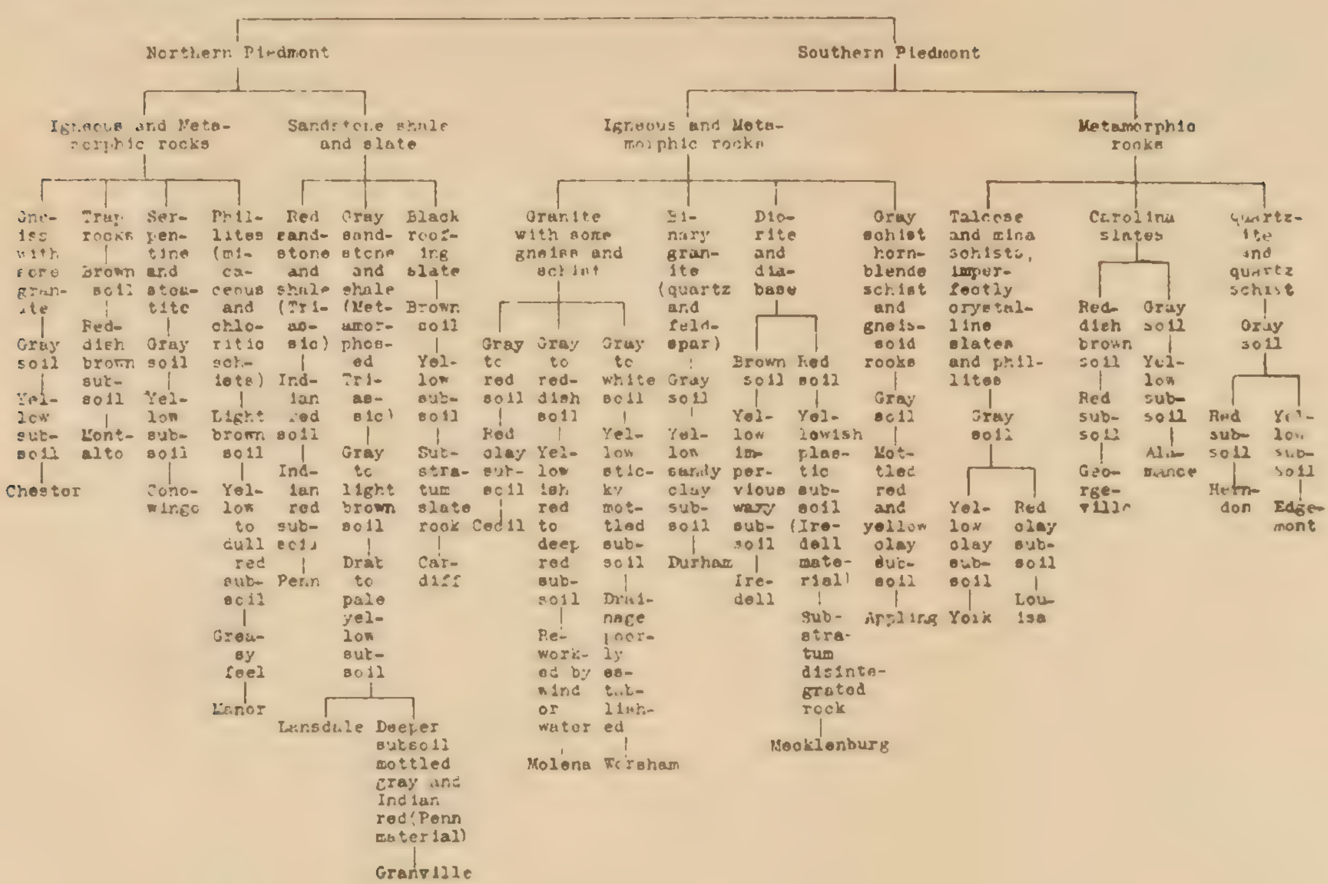
Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough gullied land	North Carolina 5; South Carolina 9	129,472
Rough stony land	Alabama 14, 24; Georgia 13; North Carolina 11; Pennsylvania 6, 12.	31,040
Barrens	Maryland 3, 5; Pennsylvania 6; Virginia 1	15,200
Rock outcrop	Alabama 33; Georgia 5; North Carolina 10; South Carolina 17	1,536
Total		177,248

[1] For key to numbers in this column see p. 733.

Bulletin 96, Bureau of Soils, U. S. Dept. of Agr. Fig. 1.

Revision of September, 1912. Key to the Soils of the Piedmont Plateau Province.



SOILS OF THE APPALACHIAN MOUNTAIN AND PLATEAU PROVINCE.

By Hugh H. Bennett.

DESCRIPTION OF THE PROVINCE.

The soil region designated as the Appalachian Mountain and Plateau province embraces three subdivisions of the Appalachian system, which extend from New Jersey and northern Pennsylvania to central Alabama. They are: (1) The Blue Ridge region on the east and southeast side; (2) the Cumberland-Allegheny plateau on the west; and (3) the Appalachian ridge and valley belt between. The province also includes two subordinate outlying divisions which are important and related to the three main divisions: (1) The Ouachita and Boston Mountain region of the Ozark uplift west of the Mississippi River, and (2) the area of Coal Measures rocks in western Kentucky and southern Indiana. The soils of the associated limestone valleys, together with those of the Highland Rim, the Central Basin of Tennessee and the Bluegrass Region of Kentucky, belong in another soil province, the Limestone Valleys and Uplands.

The three subdivisions of the Appalachian region which constitute the greater part of the soil province form a broad belt approximately 900 miles long. The main structural forms, including mountains, ridges, and valleys, lie in a general northeast-southwest direction.

From the narrow Highlands of New Jersey the province widens to about 200 miles in Pennsylvania, and attains a maximum breadth of about 270 miles at a line running northwest to southeast through Afton, Va. Southward from this line there is a gradual narrowing to an approximate width of 200 miles on a line extending across the province along the Kentucky-Tennessee and North Carolina-South Carolina boundaries. Where the province joins the Coastal Plain in Alabama its width is about 100 miles.

The region including the three main divisions of the Appalachian soil province is bordered on the southeastern or Atlantic side by the Piedmont Plateau, along the southern end in Alabama by the Gulf Coastal Plain, and on the northwestern or interior side by the limestone regions of Tennessee, Kentucky, and Ohio, and the region of glaciated soils in Ohio and Northwestern Pennsylvania. Its northern extension in New York, Pennsylvania, and New Jersey has been glaciated.

The Appalachian system as a physiographic province extends through New York into western New England and covers a large territory. Practically all of this northern extension has been glaciated and therefore its soils, with the exception of small scattered areas of residual or mainly residual materials, belong in the Glacial and Loessial province.

The outlying subordinate region embracing the western coal fields development of the Appalachian province in western Kentucky comprises a relatively small area bordering Green River and extending from the vicinity of Bowling Green to the strip of loessial soils along the east side of the Ohio River. The southern Indiana development comprises a still smaller area.

The Ouachita and Boston Mountain region, another outlying subdivision of the province, embraces a large area in central and northern Arkansas and eastern Oklahoma. The Boston Mountains border the Arkansas River Valley on the north from the vicinity of White River westward to eastern Oklahoma. The Ouachita Mountains comprise a nearly similar area south of the Arkansas Valley, extending from the neighborhood of Little Rock on the east to the vicinity of Colgate, in Oklahoma.

THE BLUE RIDGE BELT.

The eastern part of the Appalachian Mountain and Plateau province lies in the Blue Ridge belt, which extends from the glacial boundary in the Highlands of New Jersey southwestward to central Alabama. The northern extension of the same physiographic region in New York and New England has been glaciated, and from the

standpoint of soil classification belongs in the province of glacial soils. This belt of mountains is made up of one or more ridges and irregular spurs, with isolated peaks and with relatively short ranges whose direction does not conform to the prevailing northeast and southwest trend of the rocks and land forms.

From southern Virginia to the vicinity of Harrisburg, Pa., the Blue Ridge, including South Mountain in Pennsylvania, with some minor parallel ranges, constitutes the entire belt. North of the wide gap in the vicinity of the Susquehanna River, occupied by limestone valleys, the Durham and Reading hills of Pennsylvania and their northern extension, the Highlands of New Jersey, constitute the northern part of the division.

Southward from southern Virginia the Blue Ridge belt widens into a complex system, the Blue Ridge proper continuing as the eastern border range to the vicinity of Canton, Ga., and separating the system from the Piedmont Plateau, while the Unaka chain, diverging from the Blue Ridge near the Virginia line, marks the western boundary, extending through eastern Tennessee, with its base close to the North Carolina line, into Georgia. Between these higher rims there is an interior mountain region in which numerous lofty peaks rather irregularly arranged and short ranges with high valleys occur. Detached groups of mountains that stand out several miles east of the Blue Ridge, such as the Brushy Mountains of North Carolina, which at a distance of 15 to 25 miles nearly parallel the Blue Ridge, and the Saluda Mountains of North Carolina and South Carolina, which have a general east and west direction, are also included in the Blue Ridge division.

In North Carolina the Blue Ridge system has an approximate width of 75 miles, but it narrows southward until in the vicinity of Cartersville, Ga., it is only a few miles wide. From this point the system extends as a rather narrow, irregular belt to Talladega, Ala. Between the Susquehanna and Potomac Rivers the Blue Ridge consists of a narrow range with an elevation of about 1,000 to 1,300 feet above the sea level, and in Virginia the range becomes broader and the crest gradually rises to over 4,000 feet near Luray, where the width is from 10 to 16 miles. This northern portion of the range is flanked on both sides by moderately steep slopes, the base on the Atlantic side sharply marking the western boundary of the Piedmont, and on the interior side the eastern boundary of the limestone valleys. Grandfather Mountain, in North Carolina, with an altitude of 5,964 feet, is the highest point in the Blue Ridge chain. From the culminating elevations in North Carolina the crest of the Blue Ridge gradually declines southward to something like 1,000 feet in the vicinity of Cartersville, Ga.

From southern Virginia southward the range is wider and more massive than in its northern portion and its crest lies farther from the Piedmont border. Many spurs occur along the eastern slope, and broad valleys and coves wind back among the mountain ridges and peaks in such a way that the base is not everywhere easily distinguished from the Piedmont. Typically, the Blue Ridge is made up of rounded knobs and shoulders of smooth contours, with frequent conspicuous "water gaps" which are occupied by streams, often a thousand feet or more below the crest of the near-by peaks. Rocky cliffs are comparatively rare, and a large part of the range is covered with soil which is available for agriculture.

The Unaka chain, including several parallel ridges, reaches a greater average altitude than the Blue Ridge. The slopes are prevailingly steeper and rougher, and the soil is generally thinner, although sufficient over the greater part of the area to support a forest growth. The ridges of this chain are similar to those of the Appalachian Ridge belt in that they are long and straight and have fewer spurs such as those of the Blue Ridge Mountains. The crest of the Unakas approximately follows the North Carolina-Tennessee boundary from the Cohutta Mountains of Georgia to the Virginia line. This chain has various local names, including the Great Smoky Mountains and Stone Mountains.

The peaks of the intermontane region between the border ranges of the southern Appalachian Mountains, the Unaka chain, and the Blue Ridge, as seen in a panoramic view from an overlooking elevation, are distributed irregularly without arrangement into groups of ranges. There are, however, within this interior region ranges which in some degree are connected with the higher ranges rimming the basin. A number of the interior ranges do not have the prevailing northeast-southwest trend of the system. In general, the mountain peaks of this division rise to a plane between 4,000 and 5,000 feet above sea level, the highest elevations being attained toward the north. Mount Mitchell, with an elevation of 6,711 feet, the highest point east of the Mississippi River, is situated in that section in which the Unakas and the Blue Ridge begin to merge.

DRAINAGE.

South of the Roanoke River the Blue Ridge is the main divide between the Gulf and Atlantic drainage, the water of the eastern slope being carried southeastward directly to the Atlantic Ocean, while the flow off from the interior side of the crest is westward to the large streams of the Appalachian Valleys, such as the Tennessee and Coosa Rivers, and thence in a southerly direction to the Gulf. The Unaka chain and most of the intermontane region, which is confined largely to North Carolina and Georgia, are drained by streams emptying into the Gulf. These usually flow through relatively broad, open valleys with rounded, steep, and gentle slopes in the intermontane region, but they have cut deep gorges through the chain forming the western rim of this portion of the Appalachians.

North of the Roanoke most of the streams, with the exception of the Kanawha (New) River rising in the Appalachian Valley or the plateaus of the west, pass through the mountains in deep gorges or gaps, like that of the Potomac River at Harpers Ferry, and flow across the Piedmont to the Atlantic. The headwaters of the Kanawha carry the main drainage from a large section of the Appalachians in western North Carolina and southwestern Virginia across the Great Appalachian Valley, and the Appalachian ridges, through the Allegheny Plateau to the Ohio.

GEOLOGY.

The rocks of the Blue Ridge are closely related to those of the Piedmont—granites gneisses, schists, diorite, gabbro, and quartzite representing the more common varieties. Toward the western border of the southern Appalachian Mountains the igneous rocks tend to give way to metamorphic varieties, as schists and quartzite. Some unaltered stratified rocks, such as conglomerates and sandstone, occur in the western border ranges, and there are small developments of marble in various parts of the system.

Along broad lines the topography of the region conforms with the structural character of the rocks. The main ridges generally correspond with the position and the prevailing northeast and southwest direction of the more resistant rocks. Erosion has affected the relation between the surface form and rock attitude over local areas, particularly in the southern portion of the system.

THE CUMBERLAND AND ALLEGHENY PLATEAUS.

The Allegheny and Cumberland Plateaus comprise, respectively, the northern and southern portions of the western slope of the Appalachian system. This division of the Appalachian province is sharply defined along the greater part of its eastern boundary from the glacial region in northeastern Pennsylvania to the Coastal Plain in central Alabama by the bold escarpment marking the western border of the Appalachian Valley, which is known as the Allegheny Front in Pennsylvania, Maryland, and West Virginia, and as the Cumberland Escarpment in Kentucky, Virginia, Tennessee, Georgia, and Alabama.

In northeastern Pennsylvania the escarpment is indistinct, except for local developments, but southward it faces the Appalachian ridge region with the prevailingly characteristic cliff-like front, from about the central part of the State to the Maryland line, and thence across western Maryland and eastern West Virginia. The plateau front continues in the Cumberland Escarpment, which stands out with a fair degree of boldness along the greater part of its length from southwestern Virginia through southeastern Kentucky, eastern Tennessee, and northwestern Georgia, although it does not maintain such sharp definition as in its northern portion. In Alabama it is developed with only moderate distinctness along the eastern wall of Lookout Mountain, and from there southward the front is gradually obscured until the Cumberland Plateau region passes beneath the Coastal Plain deposits in the central part of the State.

The elevation of the plateau along the front rises from about 2,000 feet above sea level in northern Pennsylvania to about 2,800 feet at the Maryland-Pennsylvania line. South of the Potomac the crest of the escarpment rises to a culminating elevation of something over 4,000 feet in West Virginia. It reaches an altitude of approximately 4,000 feet in the Big Black Mountains of Virginia and Kentucky. From an elevation of about 2,000 feet in central Tennessee the surface declines to 1,500 feet in northeastern Alabama and finally to 500 feet in central Alabama. The northern division of the plateau—the Allegheny Plateau—slopes away from the front to the northwest, while the southern division is tilted to the southwest.

In northwestern Pennsylvania the width of the plateau between the front along the western edge of the Appalachian Ridge division forming its eastern boundary and the region of glaciated soils on the west is approximately 100 miles. From the escarpment edge in northeastern West Virginia, along a line through the southwestern corner of Maryland to central Ohio, it is about 175 miles wide. This is the broadest portion of the plateau region. Southward the plateau is wedge shaped, narrowing between the valley region and the Highland Rim limestone formations of Kentucky and Tennessee to a breadth at Chattanooga of 30 to 40 miles. It becomes broader again along a line from central to northwestern Alabama, where the plateau joins with the Coastal Plain.

A plateau type of topography, or an even sky line indicative of an original plateau configuration, prevails throughout this great region. In places ridges with intervening valleys, generally parallel with the frontal escarpment, stand out prominently. Erosion has severely disfigured the surface over large areas, but even in such deeply dissected sections the skyline presents an even upland level, indicating the original smooth character of the land.

In Alabama and southern Tennessee erosion has carved deep valleys and coves, giving rise to elongated detached plateaus and mesalike table-lands. Only isolated remnants of the original plateau remain in northern Alabama. To the west of Sand Mountain, south of the Tennessee River, there is a broad area of partially dissected table-land which gradually sinks southwesterly beneath the Coastal Plain deposits. There are considerable bodies of typical plateau country in southern and central Tennessee, but northward from this section through northeastern Tennessee, southeastern Kentucky, West Virginia, eastern Ohio, and southwestern Pennsylvania the plateau has been so deeply and minutely dissected that the surface configuration is dominantly strongly rolling and hilly, with occasional smooth areas on the crests of the broader irregular, winding ridges. Much of this eroded region is too steeply sloping for safe cultivation, especially near the Allegheny Front. Toward the northwestern border, however, the relief is not so great, and a larger proportion of the land is suitable for tillage.

A large part of the Allegheny Plateau is drained by the Ohio River and the tributaries entering it from all directions. A number of large streams, such as the Potomac and Susquehanna, rise in the eastern portion of the plateau and flow directly through the ridges and mountains on the east to the Atlantic Ocean. The valleys of the Allegheny Plateau vary from deep V-shaped gorges to fairly broad valleys. Many of these are bordered by large strips of flood-plains soils and by low and high terraces which were the flood plains during former stages in the development of the valleys. The Kanawha River is unique in its direction of flow. Rising in the Blue Ridge, this stream crosses the Great Appalachian Valley and the Appalachian ridges, enters the escarpment of the Allegheny Plateau in a canyon 1,500 feet deep, and flows northwesterly across the plateau through a deeply intrenched valley into the Ohio. The Ohio is fringed with valuable stretches of overflow bottoms and elevated terraces ranging from 30 feet to 200 feet or more above the river level.

The Cumberland Plateau is drained principally by the Tennessee and Black Warrior Rivers and by the headwaters of the Coosa and Cumberland Rivers. Strips of moderately wide bottoms occur in places along the streams of this region, especially on the concave side of the bends, but terraces are less extensive than in the Allegheny Plateau.

The rock strata of the Appalachian Plateau lie in a nearly horizontal position as compared with the intensely folded beds of the Appalachian Ridge region to the east. They dip in varying degrees, though with a comparatively slight average slant, northwesterly in the Allegheny division and southwesterly in the Cumberland division. There are some broad anticlinal and synclinal folds which, although they have been partly obscured by decay and erosion, give rise to some perceptible topographic features.

The plateau features of the region are due to the relatively horizontal position of the bedded rocks, while the definite areas of table-lands directly result from the resistant character of the horizontal capping rocks of sandstone and conglomerate. Where the superficial rocks consist of these resistant beds the surface has naturally weathered down slowly, so that the highest and smoothest areas occur in these localities. The surrounding country of softer rocks, such as thin-bedded sandstones and shales, has been worn to lower levels. The isolated plateaus or mesas of southern Tennessee and northern Alabama are capped with sandstone which has been more resistant to weathering than the underlying limestone and shale. As the softer rocks beneath decay the sides of the plateaus recede, the sandstone above finally breaking off in such a way as to form steep-walled flanks. Differences in the power of the rocks to resist the degradation effected by weathering and erosion account for the development of the plateau escarpments of the region.

THE APPALACHIAN RIDGE BELT.

Between the Allegheny-Cumberland escarpment and the western border of the Blue Ridge belt there is a broad structural belt of limestone valleys and ridges and mountains whose crests reach a plane somewhat lower than the summits of the regions on either side. The limestone valleys included in this Appalachian Valley region are not simply valleys which belong to single river systems, but they represent areas whose surfaces have been lowered by the weathering of the included rocks, while the ridges and mountains of the region mark the location of the more resistant rocks. The rock strata of the Appalachian Ridge division have been intensely folded and upturned at various angles, and the present surface configuration varies with the character of the outcropping strata. The edges of the more resistant sandstone and conglomerate beds stand out in long, steep-sloped, sharp-crested ridges and mountains. These conform in direction with the limiting highlands on both sides, the Allegheny-Cumberland Plateau and the Appalachian Mountains, and parallel the intervening limestone valleys representing the worn-down surface of upturned edges of the less resistant limestones and shales.

Along the eastern side of the Appalachian Ridge and valley belt the dominant limestone rocks have been degraded until the land surface stands 1,000 feet or more below the crest of the Unaka-Blue Ridge chain. This low region, constituting the Appalachian Valley proper, is a deep limestone valley, virtually continuous from northern Pennsylvania to central Alabama. Sandstone and shale ridges are infrequent and of prevailingly low relief. But to the west of the Appalachian Valley there are many higher parallel ridges which collectively comprise the Appalachian Valley mountains and ridges. These are known in the northern portion of the region as the Allegheny Mountains or Allegheny Ridges, and in different localities throughout the belt by various local names. For great distances they follow the upturned edges of hard rocks.

Immediately to the west of the main limestone valley (the Appalachian Valley) there is a practically continuous ridge known as North Mountain and as Kittatinny or Blue Mountain, which varies in height from 200 to 1,000 feet or more above the valley floor, and which has a length of 400 miles from Virginia across Maryland to northern Pennsylvania. West of this long mountain in the northern portion of the belt the region is divided up into many sharp, high mountains which succeed one another in crescent-shape outline to the Allegheny escarpment. Between these ridges there are a number of long, smooth-floored, broad and narrow valleys, such as Nittany and Wyoming Valleys of Pennsylvania, which represent the smaller counterparts of the limestone valley in the eastern part of the region. Divergent coves and narrow drainage gaps cut into or through the ridges at various angles. Many of the streams follow the valleys for long distances, to turn suddenly through the ridges or to enter larger streams crossing from the Allegheny Plateau region to the Atlantic Ocean.

In the southern division some of the mountain ridges of the Appalachian Ridge belt, such as Clinch Mountain in Tennessee and Virginia, White Oak Mountain in southern Tennessee, and Taylors, Chattooga, and Dirtseller Mountains in Georgia and Alabama, consist of sharp, hard sandstone ridges, the crests of which approach the altitudes of the plateau escarpment to the west. Along the eastern side of this southern extension, near the western base of the massive Unakas, there is a series of still higher quartzite ridges, including Holston, Chilhowee, Starrs, and Beans mountains in Tennessee, and Weisner and Indian mountains in Alabama.

Throughout the limestone valleys of the region there are occasional low sandstone, conglomerate, and shale ridges and hills, which represent minor surface inequalities or a subordinate division of the Appalachian ridges. Their soils are considered as belonging with the Appalachian Mountain and Plateau province.

THE WESTERN COAL FIELDS OF KENTUCKY.

The Western Coal Fields, situated in western Kentucky, embrace a small detached portion of the Cumberland Plateau. The area has a lower altitude than the corresponding region to the east. Although the region is prevailingly rolling to hilly, there are many areas, such as ridge crests and low interridge country, which are sufficiently smooth to cultivate. It is bordered on the east by an extension of the Highland Rim of Tennessee, while on the west it passes beneath the strip of loessial deposits bordering the Ohio River. The region is drained by Green River and its tributaries.

THE OZARK REGION.

In northern Arkansas and eastern Oklahoma the structure and mineralogy of the rocks of the Appalachian Plateau are essentially similar to those of the Boston Mountains in the Ozarks and the Ouachita Mountains to the south.

In the Boston Mountains north of the Arkansas River the strata for the most part lie in a relatively horizontal position, but they have been deeply trenched by a complicated system of winding streams. Culminating elevations of 2,000 feet or more are attained by some of the higher peaks. The section includes considerable areas of Rough stony land and steeply sloping land, which is either unfit for cultivation or suited only to the growing of fruit crops, but there are many scattered areas which can be cultivated.

Southward from the Boston Mountains the strata dip in a general way beneath the Arkansas River in a synclinal fold, reappearing to the south of the valley in the Ouachita ranges. The strata here have been severely eroded and faulted. The section includes a series of long, roughly parallel ranges or ridges with deep, flat-bottomed valleys having a general east and west trend. Some of the streams flow along the valley troughs, but in the southern portion of the Ouachitas they frequently flow across the rock strata. As a whole the ridges are relatively rugged and range in height from 500 to 2,800 feet above sea level. Magazine Mountain has an elevation of 2,800 feet.

The rocks of the Ozark region within the Boston and Ouachita Mountains are dominantly sandstones, shales, and limestones.

SOILS.

The soils of the Appalachian Mountain and Plateau province are of residual origin. Where the surface is smooth they lie directly over the sandstones, shale, and conglomerates from which they have been largely derived. On the slopes there has been considerable movement to lower levels through creep and water action; consequently there are many strips of colluvial and partly colluvial soils. The province also includes a large total acreage of slope land over which rocks have fallen and are often so thickly strewn as to seriously interfere with or preclude tillage operations. Coarse talus material of small and large rock fragments has accumulated in many places along slopes to a depth of 5 to 15 feet. The deeper accumulations of this character are barren, and their agricultural utilization is impossible. Outcrops of bedrock and stony cliffs and escarpments unfit for the growth of vegetation are not uncommon, especially along the Cumberland-Allegheny Front and the valley walls of the deeply entrenched plateau streams. The greater part of the region, however, is mantled with sufficient soil to support a moderately heavy timber growth, and much of it is forested. Owing to the steepness of slopes and the minutely dissected surface much land having a fair soil depth is unsuited for other purposes than forestry, grazing, or the production of tree fruits.

Aside from the large extent of Rough stony land, which is mainly of no use except for forestry, and Rock outcrop, which has no value, the principal soils of the province are the loams, clay loams, silt loams, sandy loams, clays, fine sandy loams, and stony loams.

In the Plateau division the sandstone, shale, and conglomerate soils dominate almost to the exclusion of those derived from other rocks. There is a relatively small development of the Westmoreland series, derived from interbedded limestone, sandstone, and shale, in northern West Virginia and southwestern Pennsylvania.

The most extensive series of the plateaus is the Dekalb. This series also predominates in the Appalachian ridges, and is developed in scattering areas in the western portion of the eastern or Blue Ridge division. The Dekalb also occupies extensive areas in the Ozark region and the Western Coal Fields of Kentucky and in the Coal Measure rocks of southern Indiana. The Dekalb soils are derived from light-colored sedimentaries, and are marked by the grayish color of the surface layer and yellowish color of the subsoil. The silt loam, shale loam, stony loam, loam, and sandy loams cover large areas, mostly available for agricultural use. In physical characteristics several members of the series are similar to the corresponding types of the Norfolk soils of the Atlantic and Gulf Coastal Plains province. This is probably due to the Dekalb material having been derived from consolidated sediments which were originally deposited in water-worked areas and segregated by wave and tidal action, and subsequently uplifted by forces similar to those which governed the deposition and subsequent uplift of the Norfolk material. The crop values of the Dekalb soils are not so high as those of the corresponding types of associated series,

such as the Westmoreland and Upshur, which have been more or less influenced by calcareous rocks.

The Hanceville soils, confined mainly to the southern ridges and the Cumberland Plateau, are essentially the same as the Dekalb in both origin and topography, differing chiefly in the brick-red color of the subsoils.

Another important series of the plateaus and mountain ridges of the northern portion of the province is the Upshur. The members of this series are derived from Indian-red, frequently calcareous, shales and sandstones. They possess a peculiar Indian-red color, and are more productive than either the Dekalb or Hanceville. The stony loam and clay are the most important types.

A large area of the badly dissected portions of the plateau in West Virginia and southeastern Ohio is occupied by the variable Meigs clay loam, which really represents an intricate association of Dekalb and Upshur where separation on small scale maps has been found impracticable.

Throughout the Blue Ridge Mountains, the associated ranges, and the intermontane region of western North Carolina and northern Georgia the soils are largely derived from igneous and metamorphic rocks—granites, diorites, gabbros, gneisses, quartzite, and schists—similar to those of the Piedmont Plateau. Physically the soils conform with those of the Piedmont, but they differ widely from the Piedmont in topographic features.

The Porters soils are extensive throughout the region from Pennsylvania to the Alabama line. These are derived prevailingly from granite and gneiss, with various igneous rocks, and have gray or reddish surface soils and red clay subsoils. The series constitutes the Appalachian equivalent of the Cecil series of Piedmont soils. The loam, clay, and stony loam are the principal members.

Similarly the Talladega and Chandler series, derived from schistose rocks, are the Appalachian equivalents of the Louisa and York series, respectively. These soils are not so productive as the Porters, having about the same relation to the Porters as exists between the Cecil and the Louisa and York. They are widely developed in the western and southern portions of the southern Appalachian Mountains.

An extensive area is occupied by the belt of Berks soils which extends in the shape of a crescent from New Jersey across Pennsylvania into Maryland, near the western margin of the Appalachian Valley. The Berks soils are derived from slaty shales and shaly sandstones of the Utica formation, and the slates of the Hudson formation (Martinsburg). The types have grayish-brown soils and yellowish subsoils and resemble the Dekalb except in their greater productivity. The shale loam and silt loam are the most important types.

The Conasauga and Armuchee series comprise flat to undulating valley soils which topographically belong with the soils of the limestone valley division of the Limestone Valleys and Uplands province. They have been provisionally placed in the Appalachian province on account of their origin from shales and their respective resemblance to the Dekalb and Hanceville. They have been mapped chiefly in Georgia and Alabama as low, flat areas, locally called "flatwoods."

Several series have been encountered only in restricted localities. The Allis and Palatine are local series, representing unglaciated residual material occurring beyond the glacial boundary in the northern extension of the Allegheny Plateau. The Chemung, Colyer, and Morrison are also of local development, and either on account of their small extent or low producing capabilities are of relatively little importance.

The Lickdale is the only poorly drained series of the northern portion of the province so far mapped. Soils of this character occur as strips along lower slopes where seepage keeps the land in a permanently soggy condition. In point of origin the material is essentially identical with the Dekalb, but its color is much lighter, the subsoil frequently being mottled, gray, and bluish, and its productiveness is low.

The Fayetteville soils of the Ozark region are apparently related to the Hanceville. The Conway series of the same region seems to be related to the Lickdale. Drainage is poorly established, while the presence of iron concretions and hardpan is common.

The Montevallo soils are typically developed in Alabama and Georgia, occurring in strips along outcrops of the Montevallo shales. Large quantities of the varicolored parent shales are disseminated through the soil mass. Agriculturally these soils are of a decidedly inferior order.

Aside from from the large area within the Appalachian Mountain and Plateau province which is nonarable on account of unfavorable topography, thinness of soil, or the presence of cumbersome stones, there is a large total area in which agriculture is rendered practically or wholly unprofitable by the inaccessibility of the land. In many places hauling is extremely difficult or impossible, and long journeys over rough roads to markets or shipping points are too expensive to permit profitable farming.

CLIMATE.

Agriculture in the Appalachian province is strongly influenced by the lower temperature and shorter growing season of the higher altitudes and the more favorable conditions in the lower areas. This frequently precludes the profitable production of crops which thrive at lower levels in the same latitude. On the other hand the same climatic conditions favor crops that do not succeed at the lower elevations.

Cotton production in the Appalachian province is practically restricted to northern Alabama, and even here the crop is frequently damaged by early frosts. In the Piedmont cotton succeeds as far north as southern Virginia. Apples give much better returns in protected coves and at certain elevations along the slopes where air drainage is good than in the deeper, closely inclosed valleys or in the Piedmont. In belts at certain altitudes a peculiar climatic environment seems to favor particular varieties and also to make fruiting more certain. Peaches generally do better on the crests of high ridges than on low lands, where the fruit is frequently injured by unseasonable weather. Buckwheat can be grown successfully at the higher altitudes of the southern Appalachian region. Little or no success would be expected on about the same grade of land in the adjoining Piedmont.

Some of the higher peaks of the southern Blue Ridge are nearly bare of vegetation, there being no trees, excepting possibly dwarfed, scraggy specimens, on the elevations above the "timber line." Aside from the unfavorable climate, the inaccessibility and rough character of the land precludes agricultural operations in such situations.

DESCRIPTION OF THE SOIL SERIES.

In this province 14,679,165 acres have been surveyed on the detailed scale of 1 inch to the mile, and 14,534,656 acres on the reconnoissance scale of 4 to 6 inches to the mile, with an overlap of 2,281,344 acres, making a total area covered of 26,932,477 acres. Of this amount, there are 1,775,745 acres of miscellaneous material which is mainly nonagricultural, 25,156,732 acres in which the soil series or material has been determined, and 12,918,076 acres where the soil type has been definitely established.

Most of the land which is topographically suited to agriculture gives good results, where the soil is of the proper quality, particularly with corn, Irish potatoes, small grain, apples, peaches, and grapes. A number of other crops are successfully grown.

Allen series.—The Allen series is characterized by the brown to reddish-brown color of the surface soils and the reddish-brown to red color and compact structure of the subsoils. Rounded sandstone and shale fragments are of common occurrence on the surface and occasionally throughout the surface soil. The type occurs as level to sloping lands about the mouths of gorges extending from higher lying sandstone, shale, and limestone formations. The soil usually represents mixed Dekalb and Decatur material. Drainage is well established. Good yields of cotton, oats, corn, sorghum, and forage crops are secured.

Area and distribution of the soil of the Allen series.

Soil name.	State or area.[1]	Acres.
Allen fine sandy loam	Georgia 18	1,408

[1] For key to number in this column see p. 733.

Allis series.—The soils of this series range from brownish to drab or gray and are about 8 inches deep. The subsoil is usually light gray, but sometimes mottled red and gray. The soils occupy steep slopes or elevated positions, and the topography is so rolling that surface drainage is good. On account of the heavy character of the subsoil, however, artificial underdrainage is frequently necessary. The soils are derived through weathering of light-colored soft shales, the structure of which is often preserved in the deep subsoil. The soils are fairly well adapted to grasses and grains and good yields are generally secured. Dairying is conducted on some of the types of this series.

Area and distribution of the soils of the Allis series.

Soil name.	State or area.[1]	Acres.
Allis shale loam	New York 9, 17	13,248
silt loam	New York 13	384
clay	New York 9, 10	3,008
silty clay	New York 5	4,032
Total		20,672

[1] For key to numbers in this column see p. 733.

Armuchee series.—The Armuchee series includes soils whose surface layers are brown to reddish brown. The subsoils are red and prevailingly of silty clay to silty clay loam texture. These soils occur as flat to gently rolling valley lands. They are derived from interbedded fine-grained sandstone and shales, with included beds of calcareous shales or limestone. The members of the series are somewhat stronger than the corresponding members of the Conasauga, and are well suited to corn, grain, and forage crops.

Area and distribution of the soil of the Armuchee series.

Soil name.	State or area.[1]	Acres.
Armuchee silty clay loam	Georgia 18	6,016

[1] For key to number in this column see p. 733.

Berks series.—The soils of the Berks series are yellowish brown to brown, with yellowish subsoils. The series is typically developed in the eastern portion of the Appalachian Mountain region. The soils are derived from the Hudson River shales (including Martinsburg shales), which are yellow, brown, grayish, and olive colored. Purplish and Indian-red shales also occur in relatively small areas, giving rise to patches of soils of reddish color. These soils occupy rounded ridges and hills, the surfaces of which are undulating to moderately hilly. The drainage is good. These are good agricultural soils, suited to corn, oats, wheat, and Irish potatoes.

Area and distribution of the soils of the Berks series.

Soil name.	State of area.[1]	Acres.
Berks sandy loam	Pennsylvania 3	10,560
shale loam	do	172,800
silt loam	do	17,600
undifferentiated	Pennsylvania 15	210,240
Total		411,200

[1] For key to numbers in this column see p. 733.

Chandler series.—The Chandler series of soils is grayish brown to light brown. The subsoils are yellow to reddish yellow, and have a greasy feel. The types of this series are developed typically in the southern Appalachian Mountains. They are derived from metamorphic rocks, chiefly micaceous schists. Large areas of the series are rough in topography and stony. The soils are best suited to pasturage and forestry. They correspond with the Talladega series, but differ principally in the yellow color of their subsoils.

Area and distribution of the soils of the Chandler series.

Soil name.	State or area.[1]	Acres.
Chandler loam	Virginia 9	384
stony loam	Alabama 35	1,664
Total		2,048

[1] For key to numbers in this column see p. 733.

Chemung series.—The Chemung series includes light chocolate brown soils and subsoils, and fragments of the chocolate brown shales from which this series is derived are of common occurrence. The soils occupy rolling to rough country, being frequently developed on steep slopes. They are typically developed near the Allegheny Front in Pennsylvania. Drainage is well established. Only a small part of the area covered by these soils has been cultivated. They are derived from the Chemung formation.

Area and distribution of the soil of the Chemung series.

Soil name.	State or area.[1]	Acres.
Chemung shale loam	Pennsylvania 2, 8	5,376

[1] For key to numbers in this column see p. 733.

Colyer series.—The surface soil of the Colyer series is light brown and is underlain by yellow subsoil. The soils are derived from black carbonaceous shales which frequently appear within the 3-foot section. Drainage is good and sometimes excessive where the shales are near the surface. Corn, grain, and grass give good results on those areas having a good depth to the underlying rock.

Area and distribution of the soil of the Colyer series.

Soil name.	State or area.[1]	Acres.
Colyer silt loam	Kentucky 4; Pennsylvania 5, 15	9,984

[1] For key to numbers in this column see p. 733.

Conasauga series.—The Conasauga soils are light brown and the subsoils are yellow and prevailingly of silty clay loam to silty clay texture. These soils are developed typically in flat to gently rolling valley lands. They are derived from interbedded shale and limestone or interbedded fine-grained sandstone, shale, and limestone. Surface drainage is inadequate owing to the flat topography. Good yields of cotton, corn, wheat, oats, and forage crops are secured under proper treatment.

Area and distribution of the soils of the Conasauga series.

Soil name.	State or area.[1]	Acres.
Conasauga loam	Georgia 18	2,944
shale loam	Georgia 18; Tennessee 4	22,464
silt loam	Georgia 18	11,584
clay	Alabama 6, 15, 21	64,768
Total		101,760

[1] For key to numbers in this column see p. 733.

Conway series.—The soils of the Conway series are yellow, with yellowish to white subsoils. Iron concretions occur throughout the soil section. In places a ferruginous hardpan is developed in the subsoil. The surface varies from gently rolling to flat, and the drainage is poorly established, water frequently standing on the surface for

long periods after rains. Low mounds are common. The water table is usually near the surface. The soils appear to be derived from shales, although they are developed in close proximity to streams, sometimes having the appearance of terraces. The native vegetation consists principally of oaks, haw, and water-loving grasses. Cultivated areas produce only indifferent yields of corn and cotton. The soils need drainage and lime.

Area and distribution of the soil of the Conway series.

Soil name.	State or area.[1]	Acres.
Conway silt loam	Arkansas 1	38,912

[1] For key to number in this column see p. 733.

Dekalb series.—The surface soils of the Dekalb series are gray to brown, while the subsoils are commonly some shade of yellow. The soils are derived from the disintegration of sandstones and shales, from Silurian to Carboniferous in age. The surface features consist of gently rolling tablelands, hills, and mountains. The soils are generally not very productive. The stony and sandy members of the series are adapted to orchard fruits, while the heavier soils make good hay and pasture land.

Area and distribution of the soils of the Dekalb series.

Soil name.	State or area.[1]	Acres.
Dekalb sand	Kentucky 4; Pennsylvania 5	20,480
stony sand	Pennsylvania 5	70,016
loamy sand	West Virginia 7	448
sandy loam	Alabama 4, 6, 15, 16; Ohio, 6; Pennsylvania 10; Tennessee 10, 11; West Virginia 8, 10.	565,844
stony sandy loam	Alabama 28; Pennsylvania 2, 8	72,704
fine sandy loam	Alabama 3, 4, 11, 15, 20, 21, 26, 28, 37; Georgia 18; Kentucky 2, 4: Missouri 22; Pennsylvania 2, 5, 6; Virginia 9.	909,504
loam	Alabama 6, 11; Kentucky 2; Pennsylvania 2, 3, 5, 6, 8; West Virginia 4, 9, 10.	281,344
stony loam	Alabama 6, 10, 11, 16, 20, 37; Georgia 18; Maryland 7; North Carolina 12; Pennsylvania 1, 2, 3, 5, 6, 8, 9, 10, 11, 12; Tennessee 4, 5, 10, 11; Virginia 1, 7, 9; West Virginia 3, 5, 9.	1,298,132
gravelly loam	Pennsylvania 12	4,800
shale loam	Alabama 6, 11, 15, 21, 37; Kentucky 2, 4; Maryland 7; Pennsylvania, 2, 5, 6, 8, 9, 10, 11, 12; Tennessee 4, 5; Virginia 1, 3, 7.	1,067,700
silt loam	Alabama 10, 15, 21, 28, 35, 37; Indiana 9; Kentucky 2, 4, 7; Ohio 5, 6; Pennsylvania 2, 5, 8; Tennessee 4, 5, 10; Virginia 9; West Virginia 1, 2, 4, 5, 6, 7, 8, 10	1,320,256
stony silt loam	Alabama 15; Pennsylvania 2, 5; West Virginia 2	344,640
clay loam	Pennsylvania 5	15,488
silty clay loam	West Virginia 1, 5	259.968
clay	Alabama 4, 27; Ohio 3; Pennsylvania 8; West Virginia 9	131,520
undifferentiated	Pennsylvania 13, 14, 15, 16	9,546.112
Total		15,908,956

[1] For key to numbers in this column see p. 733.

Fayetteville series.—The Fayetteville series consists of grayish-brown to brown soils with yellowish-brown to reddish-brown subsoils. They are rather intermediate between the Dekalb and Upshur series. The soils are formed by the weathering of sandstones and shales and are found throughout a large part of western and northwestern Arkansas and eastern Oklahoma. They are considered moderately fertile soils.

Area and distribution of the soils of the Fayetteville series.

Soil name.	State or area.[1]	Acres.
Fayetteville fine sandy loam	Arkansas 1	17,216
loam	do	44,352
stony loam	do	118,400
Total		179,968

[1] For key to numbers in this column see p. 733.

Hanceville series.—The Hanceville series has light-brown to reddish-brown surface soils and red and moderately friable subsoils. The topography ranges from rolling to steeply rolling. The soils are derived from sandstones and shales, which in places appear to be higher in iron-bearing minerals than the rocks giving rise to the Dekalb soils. The soils are a little stronger than the corresponding types of the Dekalb series, but are adapted to about the same crops.

Area and distribution of the soils of the Hanceville series.

Soil name.	State or area.[1]	Acres.
Hanceville fine sandy loam	Alabama 3, 28, 37	32,128
loam	Alabama 11, 15	3,776
stony loam	Georgia 18	1,728
silt loam	Alabama 37	95,168
Total		132,800

[1] For key to numbers in this column see p. 733.

Jefferson series.—The Jefferson soils are located in saucer-shaped upland areas where clayey shales have been surrounded by a rim of more arenaceous shales and sandstones, and along the sides of V-shaped valleys where colluvial material has collected. In some cases the basal material represents a former valley floor below which drift has accumulated over the surface in such a way as to effect the present V-shaped configuration. The soils have been derived from the colluvial wash, creep, and drift from the Dekalb and Westmoreland soils. The most common types are the silt loam and silty clay loam. These soils are too well drained and too productive for classification with the Lickdale soils. Good yields of general farm crops are obtained, but the types are best adapted to corn, grass, and forage crops.

Area and distribution of the soil of the Jefferson series.

Soil name.	State or area.[1]	Acres.
Jefferson undifferentiated	Pennsylvania 15, 16	40,320

[1] For key to numbers in this column see p. 733.

Lickdale series.—The soils in the Lickdale series are grayish and the subsoils are of mottled yellow, gray and bluish color and intractable structure. The types usually occupy slopes where drainage is poor owing to the accumulation of seepage water. These soils are derived from brown, gray, olive, and bluish shales and from sandstone. They have not been used extensively for agriculture owing to their poor drainage and unfavorable position. With the establishment of good drainage grasses do well. The Lickdale soils are closely associated with the Dekalb.

Area and distribution of the soils of the Lickdale series.

Soil name.	State or area.[1]	Acres.
Lickdale stony loam	Alabama 35	4,416
shale loam	Kentucky 4	20,416
clay loam	Pennsylvania 2, 3, 6, 8, 10, 11, 12; Tennessee 11	42,000
Total		66,832

[1] For key to numbers in this column see p. 733.

Meigs series.—The Meigs series is variable in character, and particularly in color, which ranges from the Indian red of the Upshur to the gray or pale yellow of the De Kalb. The soils are derived from red, fine-grained standstone and shales and from grayish sandstones and shales. The series includes some Upshur and De Kalb soils and intermediate types so intimately associated in occurrence as to preclude detail mapping on the scale of an inch to the mile. The material of the Meigs soils has been considerably mixed by erosion and by slides. The topography is prevailingly steeply

rolling. A large part of the series is so hilly that cultivation is impracticable. These soils are best suited to grass and the production of hay. Some of the smoother slopes and hill and ridge tops are suited to wheat, corn, oats, and forage crops.

Area and distribution of the soil of the Meigs series.

Soil name.	State or area.[1]	Acres.
Meigs clay loam	Ohio 6; West Virginia 1, 2, 4, 5, 6, 7, 8	2,642,944

[1] For key to numbers in this column see p. 733.

Montevallo series.—The surface soil of the Montevallo series is light brown and shallow. The subsoil material is usually purplish, red, and reddish brown or yellowish brown in color, and consists usually of partially disintegrated shale. Iron ore frequently occurs in workable quantities in the parent formation. The topography is prevailingly rolling, steep, narrow ridges being of common occurrence. These are poor agricultural soils.

Area and distribution of the soils of the Montevallo series.

Soil name.	State or area.[1]	Acres.
Montevallo stony loam	Alabama 35	4,032
shale loam	Alabama 3, 6, 8; Georgia 18	26,944
Total		30,976

[1] For key to numbers in this column see p. 733.

Morrison series.—The soils of the Morrison series occupy the irregular and much eroded ridges and rounded hills of the "barrens" region. They are derived from a number of rocks, mainly sandstones, the exact geological horizon of which has not been definitely established. The drainage of the sandy members is excessive. Little or no agricultural development has taken place, except in the heavier types which have been used in a small way for general farm crops. The heavier members are adapted to general farming and to the production of berries and certain vegetables, while the sandy types could probably be used for vegetables.

Area and distribution of the soils of the Morrison series.

Soil name.	State or area.[1]	Acres.
Morrison sand	Pennsylvania 2, 5, 8	2,112
sandy loam	Pennsylvania 5, 8	19,712
stony sandy loam	Pennsylvania 2	3,520
fine sandy loam	Pennsylvania 8	1,600
loam	Pennsylvania 5	5,760
stony loam	do	2,048
clay loam	do	1,280
undifferentiated	Pennsylvania 15	16,960
Total		52,992

[1] For key to numbers in this column see p. 733.

Palatine series.—The surface soil and subsoil of the Palatine series is dark brown or black, the color becoming increasingly dark with depth. The soils, while not absolutely residual in origin, are so strongly influenced by the residual material entering into their composition as to be characterized by the dark color and calcareous nature of the rocks which they directly overlie. The soil materials are derived chiefly from the Utica and Hudson River shales and limestones. A small amount of glacial material is mingled with the débris from these rocks. The disintegration of the shales is very rapid.

The topography is rolling to hilly, and the series is found only where the Utica and Hudson River formations have been left practically uncovered by glacial material and where the soils have been formed chiefly by postglacial weathering. The soils are fertile, strong general farming lands.

Area and distribution of the soils of the Palatine series.

Soil name.	State or area.[1]	Acres.
Palatine fine sandy loam	New York 11	1,280
silt loam	do	3,840
Total		5,120

[1] For key to numbers in this column see p. 733.

Paris series.—The soils of the Paris series are dark gray to dark brown and are usually rich in organic matter. The clay subsoils are brownish to reddish brown. Drainage is well established. These soils are developed on nearly flat table-land areas and in coves. They are well suited to such general farm crops as corn and grains.

Area and distribution of the soil of the Paris series.

Soil name.	State or area.[1]	Acres.
Paris loam	Virginia 9	1,536

[1] For key to number in this column see p. 733.

Porters series.—The Porters series includes the residual soils of the Appalachian Mountains derived from igneous and metamorphic rocks. The soils are analogous to those of the Cecil series, but are classed separately on account of the difference in topographic position. They occur at high elevations and are therefore influenced more or less by different climatic and drainage conditions. The mountainous character of the country in which the Porters soils are found renders them difficult of cultivation. On the more level and less elevated areas wheat, corn, rye and barley, and fruit, particularly apples, are produced. At a medium elevation and under suitable conditions of slope and exposure fruit is the principal crop. Cattle raising is one of the most important industries. The soils are particularly adapted to fruit culture, and this industry is rapidly extending.

Area and distribution of the soils of the Porters series.

Soil name.	State or area.[1]	Acres.
Porters sand	North Carolina 2, 13, 14, 18; South Carolina 3; Virginia 1	216,710
sandy loam	North Carolina 2, 13, 14, 18, 27; South Carolina 3; Virginia 3	393,305
fine sandy loam	South Carolina 13	24,128
loam	North Carolina 2, 13, 27; South Carolina 13	436,160
stony loam	Georgia 4; North Carolina 1, 14, 26; Pennsylvania 1	81,734
black loam	North Carolina 2, 13, 14, 18, 27; Virginia 1, 3	193,550
clay loam	South Carolina 13	26,432
clay	North Carolina 2, 13, 14, 18, 27; Pennsylvania 1; South Carolina 3, 13; Virginia 1, 3, 7; West Virginia 3.	292,509
undifferentiated	Pennsylvania 15	37,824
Total		1,702,352

[1] For key to numbers in this column see p. 733.

Talladega series.—The soils of the Talladega series are grayish brown to light brown. The subsoils are red and have a greasy feel. The series is typically developed in the southern Appalachian Mountains, generally occupying strongly rolling to mountainous country. The soils are derived from metamorphic rocks, principally micaceous schists. Large areas of the Talladega soils are best suited to forestry and pasturage. The smoother areas give moderate results with corn, forage crops, and cotton. The

soils are probably stronger than those of the Chandler series, from which they differ physically chiefly in the red color of their subsoils.

Area and distribution of the soils of the Talladega series.

Soil name.	State or area.[1]	Acres.
Talladega loam	South Carolina 13; Virginia 9	42,752
stony loam	Alabama 35	15,552
gravelly loam	Virginia 9	2,752
slate loam	Alabama 6,35	115,584
Total		176,640

[1] For key to numbers in this column see p. 733.

Upshur series.—In the Upshur series both soils and subsoils are Indian red. Some types have a grayish to grayish-red color in the surface soils. These soils are closely associated in occurrence with the Dekalb. They are derived from Indian-red sandstone and shales, frequently of calcareous nature. They occupy strongly rolling to mountainous country, and the drainage is well established. The soils of this series are generally more productive than the corresponding members of the Dekalb series.

Area and distribution of the soils of the Upshur series.

Soil name.	State or area.[1]	Acres.
Upshur sandy loam	Alabama 4, 16	8,896
stony sandy loam	Pennsylvania 2, 8	12,288
fine sandy loam	Arkansas 2	17 472
loam	Alabama 21; Arkansas 2; Pennsylvania 5, 8	20,288
stony loam	Alabama 21; Arkansas 2; Pennsylvania 2, 5, 8	159,744
shale loam	Pennsylvania 2	70,656
silt loam	Virginia 9; West Virginia 1	4,672
silty clay loam	West Virginia 7	20,288
clay	New York 9, 14; Ohio 6; West Virginia 1, 4, 6, 7, 8, 9, 10	256,000
undifferentiated	Pennsylvania 13, 14, 15, 16	390,912
Total		961,216

[1] For key to numbers in this column see p. 733.

Warren series.—The Warren soils are of gray color and the subsoils light to dark gray. The material is residual and is derived from the Conewango formation, which consists principally of gray or slate-colored shales and thin-bedded fine-grained sandstones overlain by yellowish-brown sandstones, shales, and conglomerates similar to those from which the Dekalb soils are derived. The soils are adapted to general farming purposes. Potatoes and other vegetables do well.

Area and distribution of the soil of the Warren series.

Soil name.	State or area.[1]	Acres.
Warren undifferentiated	Pennsylvania 14	85,120

[1] For key to number in this column see p. 733.

Westmoreland series.—The Westmoreland series is marked by the grayish-brown to yellowish-brown color and mellow structure of the surface soils and the yellowish-brown to yellow color and friable structure of the subsoils. The soils are derived from shales and sandstones with interbedded limestones and calcareous shales. Although the shales and sandstones predominate, there is sufficient limestone present to make these soils much more productive than pure sandstone and shale soils. Usually the parent rocks are so interstratified that the resultant soils are rather heterogeneous in character. In some places the different rocks give rise separately to definite soil

types, as the Dekalb or Brooke, but the areas of these are usually so small that separation is impracticable. The topography ranges from gently sloping to quite rolling or steep, many areas being so steep that plowing can not be safely carried on. The drainage is mainly good, and the soils generally retain moisture sufficiently to meet the requirements of crops even in dry spells. These soils are very productive, being particularly adapted to corn, oats, wheat, grass, potatoes, apples, peaches, plums, cherries, berries, and a number of vegetables.

Area and distribution of the soils of the Westmoreland series.

Soil name.	State or area.[1]	Acres.
Westmoreland fine sandy loam	Pennsylvania 18	960
stony loam	do	832
silt loam	Pennsylvania 2, 18	492,544
silty clay loam	West Virginia 1, 5	166,080
undifferentiated	Pennsylvania 16	1,911,168
Total		2,571,584

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The sand group is not developed extensively in the Appalachian Mountain and Plateau province, but it includes some moderately large areas, especially in the plateaus and the southern Appalachian Mountains. These soils are derived largely from highly siliceous sandstone, carrying a small amount of fine grains. Owing to their coarse texture and open structure the soils are droughty and of low agricultural value. They have not been cultivated to any considerable extent, and where used the yields have not been satisfactory. With heavy manuring vegetables could probably be grown with profit in localities close to large cities. They are best adapted to the production of fruit, particularly peaches and grapes.

The Porters sand has been mapped in large areas in the southern Blue Ridge, and is the most productive member of the group so far encountered. There is a fairly large area of the Dekalb sand in the plateaus and the Appalachian ridge region, but it has been mapped so far only in small bodies. It is an unproductive soil naturally, and has been used but little. The Morrison sand, with a patchy local development on some of the lower ridges and knolls of the Pennsylvania Valley region, is also an unproductive soil of little importance.

Dekalb sand.—The type consists of a gray to pale-yellow medium sand, underlain at a depth of about 5 inches by slightly heavier and more compact yellow to reddish-yellow sand. The immediate surface in forested areas is usually dark colored on account of the presence of organic matter. This soil occupies level to gently rolling tops of high ridges and plateaus. It is derived from sandstones and sandstone conglomerate. Forestry is the best use to which the type can be put.

Morrison sand.—The soil to about 6 inches is a loose, incoherent gray sand, containing some organic matter. The subsoil to 36 inches in depth is a loose, incoherent yellow sand or sandy loam. Small sandstone fragments are scattered on the surface. The type occupies the tops of knolls and ridges in the "Barrens," and has excellent drainage. It is derived from sandstone and supports a mixed growth of chestnut, jackpine, and scrub oak. The soil is not in cultivation and should be left in forest, owing to its low productivity.

Porters sand.—The soil is a grayish yellow sand about 10 inches in depth, overlying sand or loamy sand and masses of broken rock. Fragments of rock and huge bowlders are scattered over the surface. The type occupies mountain slopes. It is derived from granite, gneiss, and similar rocks. Where the slopes are not steep the soil is used to some extent for general farming. It is adapted to peaches and grapes.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Porters sand	North Carolina 2, 13, 14, 18; South Carolina 3; Virginia 1.	216,710
Dekalb sand	Kentucky 4; Pennsylvania 5.	20,480
Morrison sand	Pennsylvania 2, 5, 8.	2,112
Total		239,302

[1] For key to numbers in this column see p. 733.

STONY SAND PHASE.

The stony sands of the Appalachian province differ from the sand type principally in their prevailing rougher topography, and in the presence of a sufficient quantity of rock fragments to interfere with cultivation. Only one type, the Dekalb stony sand, has been mapped. Some areas of this soil have been farmed with only a fair degree of success. Most of the stony sands of the province have a low agricultural value.

Dekalb stony sand.—The soil consists of light-gray to pale-yellow medium sand to loamy sand, but the immediate surface is dark colored, owing to the presence of organic matter. The subsoil is a yellowish to reddish-yellow slightly loamy sand. The average depth of the soil is about 5 inches, but there is no distinct line of demarcation between soil and subsoil. Fragments of weathered sandstone conglomerate occur in both soil and subsoil and here and there ledges of these rocks outcrop. The land must be cleared of rocks before cultivation can be undertaken. The type occupies mountains and high plateaus and is derived from sandstones and sandstone conglomerate. Very little of it is under cultivation. Fair yields of wheat, rye, and oats are secured. Buckwheat and potatoes can be grown with fair success with liberal addition of manure.

Area and distribution of the stony sand.

Soil name.	State or area.[1]	Acres.
Dekalb stony sand	Pennsylvania 5	70,016

[1] For key to number in this column see p. 733.

LOAMY SAND PHASE.

The loamy sands of the Appalachian province differ from the sands in having a higher percentage of fine particles which render the soil more retentive of moisture and consequently a little more productive. Accessible areas can be profitably farmed, especially to vegetables, peaches, and certain varieties of grapes.

Dekalb loamy sand.—This type consists of a light-brown loamy sand underlain at an average depth of about 8 inches by pale-yellow loamy sand which usually becomes coarser in depth, grading into light sandy loam. It is developed on or near the crests of ridges and is excessively drained. The type is derived from coarse-grained sandstone. Where liberal quantities of vegetable matter are incorporated with the soil and moderate applications of fertilizers are made fair yields of corn, wheat, oats, rye, and a number of vegetables are secured. Peaches do well.

Area and distribution of the loamy sand.

Soil name.	State or area.[1]	Acres.
Dekalb loamy sand	West Virginia 7	448

[1] For key to number in this column see p. 733.

Sandy Loam Group.

The sandy loams are moderately extensive in scattered areas throughout the Appalachian Mountain and Plateau province. These soils are derived from a variety of rocks, chiefly sandstone, conglomerate, quartzite, granite, gneiss, and schist. Those derived from sandstone, conglomerate, and quartzite have agricultural values which correspond closely with, but average somewhat less productive than, the Coastal Plain sandy loams having friable sandy clay subsoils. Those soils derived from granite, gneiss, and schist have about the same value as the related Piedmont types, particularly where the surface configuration is of the same order. A wide difference in elevation, of course, influences the adaptations, but where the same crops succeed in these provinces the related types closely correspond in yields. In northern Alabama cotton is grown on the Dekalb sandy loam under similar conditions of treatment, and with about the same degree of success, except for occasional damage by early frost, as upon the Norfolk sandy loam in the southern part of the State. The Porters soils are equally as productive as the corresponding Cecil types, although the yields of the former soils over any considerable area will average lower on account of topographic interference with tillage operations and the shorter growing season.

The sandy loams are better suited to the production of early vegetables and fruit than to the general farm crops, but inaccessibility to market restricts the production of vegetables and favors a more exclusive production of general farm crops and fruits. Near some of the large cities where there is not a large area of land topographically better suited to truck crops to compete with, vegetables can be grown profitably on a market garden basis. Successful competition with the sandy loams of the Coastal Plain in the production of vegetables can not be hoped for, both on account of the later climate and inaccessible location of the Appalachian soils. The sandy loams of this province have a compensating advantage, however, in their better adaptation to apples.

The Dekalb and Porters series are the most extensive members of this group. The other types encountered occur only in small, scattered areas, and, although of some local importance, they probably will not be found in sufficient extent to constitute important types. The Porters sandy loam is a much stronger soil than the Dekalb, being better suited to the general farm crops, as well as to apples.

Berks sandy loam.—The soil is a medium to fine, light-brown sandy loam from 6 to 8 inches deep. The subsoil is a yellowish-brown, rather heavy, medium to fine sandy loam, often containing sufficient silt and clay to make it compact. Sandstone and shale fragments are often present in both soil and subsoil. The soil is derived from fine-grained, flaggy sandstone interbedded with shale. The type is rolling to hilly, well drained and susceptible to drought. It is more difficult to cultivate and less productive than the Berks shale loam and Berks silt loam. Corn, oats, wheat, rye, grass, and a few potatoes are grown, but the soil is not especially adapted to any of these crops and yields are not very satisfactory. It can be used with fair success for pasture.

Dekalb sandy loam.—The soil consists of a gray to brown light sandy loam to sandy loam from 9 to 12 inches deep. The subsoil is a yellowish-brown, slightly sticky sandy loam. The type is residual in origin, derived largely from sandstone, and occurs in rather level areas. Occasionally broken sandstone lies directly under the surface soil. The type is easily cultivated and responds readily to fertilizers, but it is not very productive. Some wheat is grown, but the average yield is not more than 7 bushels per acre. The yield of corn rarely exceeds 15 to 20 bushels, while cotton gives from 200 to 350 pounds of lint per acre. This soil is adapted to vegetables, apples, and peaches.

Morrison sandy loam.—The soil is a gray to yellow sandy loam about 8 inches deep, underlain by a yellow subsoil which becomes heavier with depth until at about 36 inches it passes into a heavy loam or clay loam. Sandstone fragments are usually present. The type occupies slopes and ridges in the "Barrens" and has excellent drainage. The soil is derived from the weathering of sandstone. Chestnut, pine, and oak, with considerable underbrush, constitute the principal vegetation. It is adapted to general farm crops and is particularly suited to truck and fruit.

Porters sandy loam.—The soil consists of a grayish-yellow sandy loam, from 6 to 15 inches deep. The subsoil is a heavy red clay. Both soil and subsoil contain fragments of quartz and other rocks. The type occupies mountainous land and is of residual origin, being derived from igneous rocks. Wheat, corn, oats, rye, potatoes, and fruit are the principal crops.

Upshur sandy loam.—The soil to a depth of about 10 inches is a gray to reddish-gray medium sandy loam. This is underlain by a deep-brown to red sandy clay. The surface of the type varies from gently rolling to hilly and rugged, and sometimes on

the steeper slopes rock fragments occur. The natural drainage is good. The soil is derived from the weathering of brown and red sandstones. The original timber growth is oak, hickory, and pine. When well cultivated good crops of cotton, corn, and wheat are produced. The type is suited also to vegetables, orchard fruits, and small fruits.

Area and distribution of the soils of the sandy loams.

Soil name.	State or area.[1]	Acres.
Dekalb sandy loam	Alabama 4, 6, 15, 16; Ohio 6; Pennsylvania 10; Tennessee 10, 11; West Virginia 8, 10.	565,844
Porters sandy loam	North Carolina 2, 13, 14, 18, 27; South Carolina 3; Virginia 3	393,305
Morrison sandy loam	Pennsylvania 5, 8	19,712
Berks sandy loam	Pennsylvania 3	10,560
Upshur sandy loam	Alabama 4, 16	8,896
Total		998,317

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

The stony sandy loams of the province merely represent areas of sandy loam which carry enough rock fragments to interfere with cultivation. These generally occupy much rougher country than the sandy loams. On account of the unfavorable character of the surface and the obstruction offered to cultivation by the rocks present, the stony sandy loams have a low agricultural value. The areas so far encountered are best suited either to forestry or the growing of fruit.

Dekalb stony sandy loam.—The soil is a loose-structured, gray to dark-gray sandy loam, 7 or 8 inches in depth. This is underlain by a yellowish, slightly sticky light sandy loam. The soil in forested areas contains considerable organic matter. The texture is such as to permit rapid leaching of fertilizers. Quartz gravel and fragments of sandstone and conglomerate are usually present in sufficient quantities to interfere with cultivation. The type occupies plateau lands and the crests of mountains, and has excellent drainage. It is derived from the weathering of sandstone, the incomplete disintegration of which has given rise to the stony character of the soil. Chestnut is the principal growth. Little of the type is in cultivation. Much of it is best suited to forestry.

Morrison stony sandy loam.—The soil to a depth of 6 to 8 inches consists of a loamy sand to light sandy loam, dark gray in the immediate surface soil and yellow below. The subsoil is a yellow light sandy loam to sandy loam, sometimes tinged with reddish. Fragments of sandstone occur on the surface and frequently throughout the soil section. The topography is rolling to rough, and the natural drainage rather excessive. Most of the type is timbered with hardwoods. It is possible that in places the type could be utilized profitably for fruit and vegetables.

Upshur stony sandy loam.—The soil to 8 or 10 inches is a reddish-gray sandy loam. This becomes sandier and redder with depth until at about 36 inches it grades into a rather loose-structured Indian-red sandy loam. Sandstone fragments and bowlders are numerous on the surface. The type occurs as high terraces along the sides of mountains and has excellent drainage. It is derived from the weathering of the red and gray sandstones of the Medina group. The soil it largely forested and supports a fair growth of chestnut and oaks. It is of low agricultural value.

Area and distribution of the soils of the stony sandy loams.

Soil name.	State or area.[1]	Acres.
Dekalb stony sandy loam	Alabama 28; Pennsylvania 2, 8	72,704
Upshur stony sandy loam	Pennsylvania 2, 8	12,288
Morrison stony sandy loam	Pennsylvania 2	3,520
Total		88,512

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams of this province are developed in rather close association with the sandy loams; but the area occupied by the former, according to the surveys so far made, is considerably smaller. The fine sandy loams are derived from finer grained sandstone, quartzite, granite, gneiss, and schist than those giving rise to the sandy loams. The corresponding members of the several series are practically identical in physical characteristics with the sandy loams except for their finer texture. This difference, however, is sufficient to make the soils of the fine sandy-loam group more retentive of moisture, and consequently more productive than their coarser relatives.

The general farm crops, especially corn and the small grains, give heavier returns than on the corresponding sandy-loam types. The crop values of those types derived from sandstone and quartzite are very nearly the same, as in case of the well-drained fine sandy loams of the Atlantic and Gulf Coastal Plains having friable sandy-clay subsoils. The types derived from granite, gneiss, schist, and other crystalline rocks correspond closely in crop values with the related Piedmont soils.

A number of vegetables, such as tomatoes, cabbage, and potatoes, can be successfully grown, although the production of these on a commercial basis is limited to favorable localities in the vicinity of the larger cities. In the production of vegetables the fine sandy loams can not compete with the fine sandy loams of the Coastal Plain, nor even of the Piedmont, both on account of the later maturity of the crops resulting from the cooler climate and on account of the inaccessibility of the land. Certain varieties of grapes and apples give fair to good returns. As a whole, this group can be used most profitably in the production of fruit, the general farm crops suited to the climate, and to a few vegetables.

The Dekalb and Porters types are the most extensive representatives of the fine sandy loam group. The Porters fine sandy loam is considerably more productive than the corresponding Dekalb type, but it is less extensive. The other fine sandy loams have a local distribution, and on account of their inextensive area are of little importance.

Allen fine sandy loam.—The soil is a brown to reddish-brown fine sandy loam from 6 to 8 inches deep. The subsoil is reddish-brown to red, compact, heavy, fine sandy loam. Rounded sandstone fragments occur on the surface and occasionally are encountered in the soil. The type occupies level to sloping situations about the mouths of gorges. The soil consists of Decatur material mixed with Dekalb material washed from higher lands. Drainage is well established. Cotton, corn, oats, cowpeas, and sorghum give good results.

Dekalb fine sandy loam.—The soil is a fine, compact sandy loam from 8 to 12 inches deep. The subsoil consists of similar material, which becomes more loamy as the depth increases. The type is derived from sandstone. The soil is naturally not productive and small crops are obtained unless it is heavily fertilized. With proper cultivation it is fairly well adapted to fruit and truck. The principal timber is chestnut and oak.

Fayetteville fine sandy loam.—The soil consists of 8 to 12 inches of gray to reddish-gray fine sand with varying amounts of silt. The subsoil is a gray to reddish-gray fine sandy clay and extends to great depths. A small amount of fine gravel is of frequent occurrence. The surface is level to gently rolling, and during years of average seasonal conditions the drainage is sufficient. The soil is derived from fine gray sandstones, such as the Millstone grit formation, which have a siliceous cement. Oaks and hickory constitute the native vegetation. The crops generally grown are corn and cotton; but it is an excellent truck soil, and profitable crops of peanuts, cowpeas, and potatoes could be secured.

Hanceville fine sandy loam.—The soil of this type is a grayish or reddish fine sandy loam 6 or 8 inches in depth, underlain by a reddish to bright-red or brick-red heavy fine sandy loam or sandy clay. The type is developed in connection with the Dekalb soils on the Appalachian plateaus and ridges and is derived from the Coal Measures sandstone. The high coloring of the subsoil seems to be due to the presence of iron salts not usually manifest in the original coloring of the parent rock. The topography is undulating to rolling and hilly. The type is adapted to general farming and to fruit.

Morrison fine sandy loam.—The soil is a gray, loose, incoherent fine sandy loam to fine sand seldom over 6 inches deep. The subsoil to 36 inches is a light-yellow, loose, incoherent, loamy fine sand to light fine sandy loam, containing considerable sand of all grades. Quartz gravel occurs on the surface and throughout the soil and subsoil. Fragments of sandstone and conglomerate also appear on the surface. The type occupies gently sloping to steep hillsides and has excellent drainage. It is

derived from Oriskany sandstone. The original growth is oak and chestnut. The soil is not suited to general farming on account of its inability to hold fertilizers and lime; but it is used for wheat, corn, oats, and gardening with moderate success.

Palatine fine sandy loam.—The soil to a depth of 8 inches is a dark-brown to black fine sandy loam. From 8 to 36 inches it is a dark-brown to black heavy fine sandy loam. Bedrock is usually encountered at a depth of 26 to 48 inches. The type is rolling to hilly with good natural drainage, and is suited to the production of corn, clover, and grass. Alfalfa is successfully grown. The soil also produces good yields of potatoes and root crops.

Porters fine sandy loam.—The soil is a gray or yellowish fine sandy loam from 6 to 12 inches in depth. The subsoil varies from a yellowish-brown, heavy fine sandy loam to a light, fine-textured sandy clay, and at depths of from 30 to 60 inches it grades into the parent rock. Eroded areas are frequent where the rock lies close to the surface. There are many small, sheltered coves where the soil is deeper and darker. The surface is rough and mountainous and drainage is excessive. The material is derived principally from the weathering of granite and gneiss. The type is forested with scrubby oak, pine, and chestnut on the ridges, while in the sheltered coves and on smoother slopes mountain laurel and rhododendron often form a dense undergrowth. Practically none of this soil is in cultivation, and it should remain in forest.

Upshur fine sandy loam.—The soil consists of a yellowish-brown fine sandy loam from 8 to 15 inches deep. The texture ranges from heavy to light fine sandy loam, but occasional small areas of loamy fine sand are found. The subsoil is usually a medium clay loam or a stiff fine sandy clay of an Indian-red or mottled reddish-brown and grayish color, but sometimes such material is separated from the surface soil by a layer of heavy fine sandy loam which grades into the typical subsoil at depths ranging from 20 to 30 inches. Over small areas a crust or hardpan cemented with iron salts has been formed in the lower part of the surface soil. In general the type occupies moderately rolling land, but it sometimes occurs in scattered areas on both steep slopes and plateaus. The soil is derived from fine-grained, brown, yellow, or gray sandstone associated usually with red sandstone and shale. The surface drainage is generally well established. The type, except in areas having a hardpan, is adapted to apples, peaches, and small fruits. Fair yields of general farm crops are obtained.

Westmoreland fine sandy loam.—The soil is a brown to yellowish-brown fine sandy loam averaging about 8 inches in depth. The subsoil is a lighter colored, heavy fine sandy loam to fine sandy silt loam or silty clay loam. The type mainly occupies high plateau areas where the drainage is good to excessive. The soil is derived from fine-grained micaceous sandstone and is influenced to a variable degree by material from the associated limestones. It is a good general farm soil, producing from 25 to 50 bushels of corn per acre, 20 to 40 bushels of oats, and 10 to 15 bushels of wheat. Grass gives only moderate yields. Vegetables do well.

Area and distribution of the soils of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Dekalb fine sandy loam	Alabama 3, 4, 11, 15, 20, 21, 26, 28, 37; Georgia 18; Kentucky 2, 4; Missouri 22; Pennsylvania 2, 5, 6; Virginia 9.	909,504
Hanceville fine sandy loam	Alabama 3, 28, 37	32,128
Porters fine sandy loam	South Carolina 13	24,128
Upshur fine sandy loam	Arkansas 2	17,472
Fayetteville fine sandy loam	Arkansas 1	17,216
Morrison fine sandy loam	Pennsylvania 8	1,600
Allen fine sandy loam	Georgia 18	1,408
Palatine fine sandy loam	New York 11	1,280
Westmoreland fine sandy loam	Pennsylvania 18	960
Total		1,005,696

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loams are the most extensive group of soils mapped in the Appalachian Mountain and Plateau province, but in all probability it will be found by a complete survey of the region that the silt loams occupy a nearly equal extent. The members of this group are derived from the shales, fine-textured sandstones, and medium to fine-

textured granites, gneisses, shists, and other crystalline rocks. While in most cases the texture of these soils is directly due to the character of the underlying rock, there are considerable areas, particularly in the Blue Ridge portion of the Appalachian Mountains, where the surface texture is more or less due to erosional processes, especially to the washing away of the original sandy surface soil material with resultant exposure at the surface of heavier material, and to the colluvial mixing of the finer and coarser materials along slopes.

The loams of this province are generally well suited to the production of apples, peaches, and grapes, some types being particularly adapted to certain varieties of these fruits. Where the surface configuration is favorable the loams also give good yields with the general farm crops, including corn, oats, wheat, rye, barley, buckwheat, and grass. The heavy texture of this group with the cool climate virtually preclude the production of most vegetables on anything like a commercial basis. Cabbage, tomatoes, turnips, and Irish potatoes can be successfully grown for the fall trade in large areas, but the early maturing truck crops generally fail to produce profitable returns in early markets. Much of the land occupied by these soils which is topographically unsuited to cultivation can be profitably used for grazing.

Heavier stock and implements are required to cultivate this grade of land than are necessary on the lighter textured soils. Also, inasmuch as the loams are more susceptible to erosion than the sandy loams, greater care is required to prevent ruinous soil washing. The steeper slopes should not be plowed at all, but seeded and cultivated with hand implements and utilized either for pasturage or for fruit trees.

The Porters loam is by far the most extensive type so far mapped. It is confined to the Blue Ridge and the central portion of the southern Blue Ridge belt. It is an excellent apple soil, and where the topography is favorable gives good results with corn, small grains, and grass. Cabbage also can be successfully produced. The Dekalb loam has a fairly extensive area in the valley mountains and ridges and the plateaus. It is much less productive than the Porters loam, but gives fair returns with corn and small grain. The other types mapped occupy rather small areas, some of them being local in distribution.

Chandler loam.—The soil consists of 8 to 12 inches of a grayish loam underlain by a yellow to reddish-yellow loam, becoming heavier and redder with depth. Sandstone and quartz fragments occur on the surface and through the soil. The surface is hilly to rolling and drainage is good. It is derived from micaceous rocks.

Conasauga loam.—This is a light-brown silty loam underlain at 12 to 15 inches by yellow silty clay loam to silty clay. The type occupies flat and gently rolling valley lands, and is derived chiefly from interbedded shales and fine-grained sandstone, with occasional layers of limestone. It gives fair yields of cotton, corn, oats, wheat, and forage crops. Grass does well.

Dekalb loam.—The soil is a fine-textured loam of light-brown or yellowish color from 10 to 15 inches deep. The texture becomes heavier as the depth increases, and the material grades finally into a light-yellow silty clay or clay subsoil, often mottled with gray or drab, which extends to a depth of 3 feet or more. The subsoil often rests upon a mass of partially disintegrated sandstone, beneath which bedrock is found. Sandstone fragments are usually scattered over the surface and some iron concretions also occur. The type occupies slopes and ridges. The topography varies from deeply dissected to broad and gently rolling. The soil is well drained, and in some situations is subject to erosion. This is a residual soil derived from very fine grained sandstone and shales. It is an excellent type for general farm crops, potatoes and other vegetables, melons, small fruits, and tobacco. Corn yields from 35 to 60 bushels, hay from 1 to 1½ tons, oats from 35 to 50 bushels, and wheat about 15 bushels per acre.

Fayetteville loam.—The surface soil is mainly silt, with some fine sand. Its color is yellow to reddish yellow. The subsoil consists largely of yellow and mottled yellow and red silty clay, which usually is underlain by decomposed shale. The surface is gently rolling and only in depressed areas is drainage deficient. The soil shows a tendency toward baking and consequently water movement is slow. It is a residual soil from shales of the Coal Measures. Japan clover flourishes nearly everywhere. Most of the type is under cultivation to corn and cotton, although potatoes, cabbage, and strawberries could be grown successfully. Alfalfa and cowpeas can also be grown if lime is applied.

Hanceville loam.—To a depth of about 6 inches the soil is a dark reddish brown loam, while the subsoil is usually a brick-red silty clay. The type is derived from sandstones and shales of Carboniferous age, which, while not noticeably red, form soils of much deeper coloring than the yellowish Dekalb soils with which they are closely associated. The type, however, does not possess the dull Indian red coloring of the Upshur series. The Hanceville loam ordinarily occurs as small areas often of only a few acres. It is more productive than the Dekalb loam. Good yields of the ordinary farm crops and of fruit are secured with proper management.

Morrison loam.—The soil to a depth of 8 or 10 inches consists of a heavy loam. The subsoil is a reddish-yellow clay loam to clay. Sandstone fragments occur in the type. This soil occupies rolling land in the "Barrens." It gives good yields of general farm crops. Berries and truck crops would probably do well.

Paris loam.—This type consists of about 10 inches of a dark-brown to dark-gray loam, underlain by a brownish to reddish-brown clay which grades at about 20 inches into a heavy reddish to reddish-brown clay. Numerous high bowlders or ledges of rock outcrop irregularly. The soil is encountered on the crests and upper slopes of mountains. Drainage is good, and crop yields, particularly corn, are highly remunerative.

Porters loam.—The soil consists of a dark-red or gray loam from 6 to 15 inches deep. The subsoil is a heavy red clay. Both soil and subsoil contain fragments of quartz and other rocks. The type occupies mountain or high rolling lands. It is derived from metamorphic and igneous rocks, such as granite and gneiss.

Talladega loam.—The soil is a yellowish-gray to yellowish-brown loam 8 to 12 inches deep, containing a small percentage of sand and some small fragments of rock. The subsoil is a yellowish-red to red clay loam grading into a heavy red clay containing small angular gravel and some sand. The material has a slick, greasy feel. The topography ranges from hilly to gently rolling, and drainage is good at all times. The soil is derived chiefly from mica and talcose schists, and contains quartz and schist fragments. It is cultivated principally to corn and wheat. Oats and grasses are grown for forage crops.

Upshur loam.—The soil consists of about 8 inches of loam, varying from brown to dark Indian red in color. The subsoil is a clay loam to heavy clay, usually of a reddish-brown to a deep Indian-red color. The surface varies from flat to gently rolling or occasionally hilly. The type is derived from fine-grained, red shaly sandstone and shales. It is naturally well drained. The soil is productive and is adapted to cotton, corn, and forage crops. Vegetables, orchard fruits, and small fruits do well on the lighter and higher lying areas of the type.

Area and distribution of the soils of the loams.

Soil name.	State or area.[1]	Acres.
Porters loam	North Carolina 2, 13, 27; South Carolina 13	436,160
Dekalb loam	Alabama 6, 11; Kentucky 2; Pennsylvania 2, 3, 5, 6, 8; West Virginia 4, 9, 10.	281,344
Fayetteville loam	Arkansas 1	44,352
Talladega loam	South Carolina 13; Virginia 9	42,752
Upshur loam	Alabama 21; Arkansas 2; Pennsylvania 5, 8	20,288
Morrison loam	Pennsylvania 5	5,760
Hanceville loam	Alabama 11, 15	3,776
Conasauga loam	Georgia 18	2,944
Paris loam	Virginia 9	1,536
Chandler loam	do	384
Total		839,296

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony loams occupy an extensive total area in the Appalachian province, considerably over 1,000,000 acres of the Dekalb member of the group having been mapped.

This group of soils, in so far as the material is concerned, is practically identical with the corresponding loam types, but they differ widely in agricultural value. This is due to the presence in the stony loams of sufficient quantities of rock fragments to interfere with cultivation and to their rougher topography. The stony loams prevailingly occupy either sharp ridges and slopes where erosion has kept close pace with rock weathering or sloping areas over which fragments of stone have fallen from above.

The greater part of these soils is suited only to the production of apples, peaches, grapes, and to pasturage and forestry. Some of the smoother areas where the stones are less abundant can be cleared and successfully used in the production of corn, small grain, and occasionally such vegetables as Irish potatoes, cabbage, and tomatoes.

The Dekalb stony loam is widely developed throughout the plateau region, the Appalachian ridges, and scatteringly in the western portion of the Blue Ridge belt. The Fayetteville stony loam is an important type in the Ozark region, while the Upshur member of the group has been encountered over considerable areas both in

the plateaus and in the mountains and ridges between the plateaus and the Blue Ridge belt. The Porters stony loam has a moderate development throughout the narrow portion of the Blue Ridge Mountains and in the central portion of the broad southern extension of this division. The other types have not been found in large bodies, and are mainly local in their distribution.

Chandler stony loam.—The soil is a light-brown, grayish, or yellowish stony silty loam to heavy fine sandy loam, 3 to 6 inches in depth. The subsoil is a yellow compact silt loam or clay loam, becoming heavier with depth to about 24 inches, where a mass of broken rock is encountered. Large quantities of rock fragments of all sizes occur on the surface and through the soil. The surface is rolling to hilly and drainage is usually good. The soil is derived from micaceous talcose and greenish schists. It is generally covered with oaks and is of low productivity when cleared.

Dekalb stony loam.—The type includes a gray to yellowish sandy loam, 6 to 10 inches deep, grading into a subsoil of slightly heavier texture and yellower color. In some places the subsoil approaches silty clay. Both soil and subsoil contain large quantities of sandstone, conglomerate, and shale fragments. Broken masses of rock frequently occur directly beneath the soil. The topography is rough and broken. Owing to the character of the surface and its stony nature, the soil is not very productive, although where the clay subsoil prevails and at least a part of the stones are removed fair crops are produced. With proper location and elevation the sandy and sandy loam phases are well adapted to peaches. Where wheat is grown the soil produces a small yield of bright, heavy grain. The native growth consists mainly of chestnut and white oak, with some hickory, black gum, and red oak.

Fayetteville stony loam.—The soil is composed of various grades of rock material ranging from clay to good-sized gravel and stones. The gravel consists largely of shale and sandstone fragments, and extends to great depths. Though the texture and structure is variable over wide areas, the soil is usually of a gray to reddish-gray color and is uniformly about 14 inches deep. The subsoil varies from fine sandy and gravelly material to clay and silt. This is underlain at depths of from about 2 to 30 feet by bedrock. The type occurs on rolling to hilly uplands, and the drainage is well established. It is a residual soil derived from the shales and more ferruginous members of the Millstone grit strata of the Coal Measures. The natural vegetation is post oak, black oak, and blackjack oak, with some hickory and various shrubs. This is a promising soil for apples, peaches, and grapes. The present crops are corn, cotton, some apples, and grapes, which under existing methods give but fair yields.

Hanceville stony loam.—The soil is a light-brown to reddish-brown heavy fine sandy loam to light loam 8 to 10 inches deep. The subsoil is a red clay loam or fine sandy loam of friable structure. Fragments of red ferruginous sandstone are so abundant as to interfere materially with cultivation. The type is confined mainly to slopes. It is derived from ferruginous sandstone. The soil is best suited to forestry and apples.

Lickdale stony loam.—This type consists of 6 inches of gray to light yellowish ashy silty loam to fine sandy loam underlain by yellow silt loam, loam, or silty clay loam. Throughout the soil profile there are large quantities of sandstone fragments of all sizes. The type is derived from shale and sandstone and from débris and talus which has accumulated on mountain slopes. It is of small agricultural value. The drainage is often poor.

Montevallo stony loam.—To a depth of about 6 inches the interstitial soil consists of a light-brown, gritty silt loam or heavy sandy loam. The subsoil is a yellow or reddish yellow, greasy silty clay loam, changing to stiff, red silty clay which is underlain at about 24 inches by a mass of broken rocks. The surface is covered with rock fragments varying from small shale chips to blocks of shaly sandstone, or sandstone. Rock outcrops frequently occur. The type occupies rounded hills and narrow-topped ridges with steep slopes giving a rough surface from which drainage is excessive. The soil is residual from the degradation of sandy shales, shaly sandstone, sandstone, and probably some limestone, all of which are more or less ferruginous. It is largely timbered, and its agricultural value is very low.

Morrison stony loam.—The type is a reddish-yellow heavy sandy loam to loam resting upon a reddish-yellow heavy clay loam to sandy clay. Both soil and subsoil contain large amounts of iron-cemented sandstone fragments of varying size. On some of the higher ridges there are so many stones that the type approaches rough stony land in character. The topography is sharply rolling to hilly, with steep slopes. The soil is derived from the sandstones of the "Barrens" region. It is principally forested with chestnut, pine, and oak.

Porters stony loam.—The soil is a grayish-yellow sandy loam about 10 inches deep, mixed with fragments of sandstone and other rocks. The subsoil grades from a reddish-brown clay loam to a stiff red clay in lower depths, and contains some coarse sand and a large quantity of rock fragments. The type occupies rolling valley lands and gentle slopes of mountains. The material is mainly residual from crystalline rocks, but

some areas have been influenced by colluvial accumulations. The soil produces good crops of wheat, corn, grass, tobacco, rye, and apples.

Talladega stony loam.—The type consists of an ashy-gray, silty fine sandy loam 8 to 15 inches deep, immediately underlain by a dark-red loam to clay 36 inches or more in depth. On the surface and through the soil and subsoil large quantities of quartz fragments of varying size occur. There are enough shale fragments in the subsoil to give a slightly greasy feel. The type occupies high hills with gentle slopes, and drainage is good but not excessive. It is a residual soil derived typically from micaceous schists. Cotton and corn give fair returns on the smoother areas.

Upshur stony loam.—The soil consists of a yellowish-brown fine sandy loam from 8 to 20 inches deep, underlain by a dull-red, reddish-brown, or Indian-red fine sandy clay to clay loam. From 15 to 60 per cent of the soil mass consists of fine-grained sandstone or other rock fragments. These are found on the surface and mingled with the surface soil. In places the subsoil is entirely free from rock fragments, while in others large quantities are present. The type is moderately to steeply rolling, a large part of it being found on lower slopes leading to higher lying rough stony land. It is derived from the weathering of both sandstones and shales. Surface drainage is rapid and is often attended by injurious washing of the slopes. Barring the obstruction of stones, a large part of the type can be cultivated and is fairly adapted to general farm crops and tree fruits. The more stony areas are best used for pasturage.

Westmoreland stony loam.—The soil is a light-brown silty loam to silt loam about 10 inches deep. The subsoil is lighter in color than the soil and contains a higher percentage of clay. It grades into a silty clay loam which rests upon rock at about 2 to 3 feet. Small sandstone fragments are present in the soil in sufficient amounts to interfere with cultivation. The type occupies the crests of hills, narrow ridges, and steep slopes where erosion is often destructive. The drainage is good to excessive. Peaches give especially good results, and where the surface configuration admits of proper cultivation corn yields from 50 to 80 bushels per acre, wheat 12 to 25 bushels, oats 20 to 40 bushels, and hay 1 to 2 tons. In dry season the yields are considerably reduced.

Area and distribution of the soils of the stony loams.

Soil name.	State or area.[1]	Acres.
Dekalb stony loam	Alabama 6, 10, 11, 16, 20, 37; Georgia 18; Maryland 7; North Carolina 12; Pennsylvania 1, 2, 3, 5, 6, 8, 9, 10, 11, 12; Tennessee 4, 5, 10, 11; Virginia 1, 7, 9; West Virginia 3, 5, 9.	1,298,132
Upshur stony loam	Alabama 21; Arkansas 2; Pennsylvania 2, 5, 8	159,744
Fayetteville stony loam	Arkansas 1	118,400
Porters stony loam	Georgia 4; North Carolina 1, 14, 26; Pennsylvania 1	81,734
Talladega stony loam	Alabama 35	15,552
Lickdale stony loam	do	4,416
Montevallo stony loam	do	4,032
Morrison stony loam	Pennsylvania 5	2,048
Hanceville stony loam	Georgia 18	1,728
Chandler stony loam	Alabama 35	1,664
Westmoreland stony loam	Pennsylvania 18	832
Total		1,688,282

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loams are unimportant in this province. They have been found only in small patches, and these have a rather low agricultural value, both on account of their unfavorable topography and their intractable character.

Dekalb gravelly loam.—This type consists of a brown loam or heavy gravelly sandy loam underlain at a depth of 8 to 12 inches by light-yellow gravelly loam. The type occupies ridges and hills and sometimes the intervening depressions. It is derived from sandstone, conglomerate, and shale. The drainage is well established, and crops are liable to suffer in dry seasons from lack of moisture. The type gives low yields of the general farm crops.

Talladega gravelly loam.—This soil is a yellowish-gray loam containing a high percentage of small and large quartz fragments. The subsoil to a depth of 36 inches is a yellowish-red to red clay loam to clay having a greasy feel. The type occupies crests or slopes of hills, and is derived from schistose rocks. Except for forest purposes, the type is not highly valued.

Area and distribution of the soils of the gravelly loams.

Soil name.[*]	State or area.[1]	Acres.
Dekalb gravelly loam	Pennsylvania 12	4,800
Talladega gravelly loam	Virginia 9	2,752
Total		7,552

[1] For key to numbers in this column see p. 733.

SHALE LOAM PHASE.

The shale loams occupy a large total area throughout both the Appalachian ridges and the Appalachian plateaus. These soils have very nearly the same agricultural value as the corresponding loam types. They differ from the loams mainly in that shale fragments are present in such quantities as to interfere with cultivation, and in the somewhat more droughty character of the soil resulting from its looser structure and the readily permeable nature of the underlying rocks.

The Dekalb shale loam, which is by far the most important type, has practically the same crop adaptation as that possessed by the Dekalb loam, but its crop value is somewhat lower. The Berks shale loam, which occupies a large area in a belt extending from New Jersey across Pennsylvania into Maryland, is a much more productive soil than the Dekalb, being well suited to the production of corn, wheat, oats, rye, clover, grass, and buckwheat. The other shale loam types comprise a relatively small area.

Allis shale loam.—This type, to a depth of from 7 to 10 inches, consists of a heavy loam or clay loam, dark drab or brown in color, resting upon a subsoil of heavy loam or clay loam similar to the surface soil, except that it is a little lighter in color. Both soil and subsoil contain small, thin shale fragments, which are brittle and easily broken. On some of the steeper slopes there is no subsoil, the soil resting directly on rock. In this phase the shale fragments are larger, and occur in amounts greatly in excess of those on the gentler slopes. The type occupies steep slopes and is derived from the weathering of shale rock. It is well adapted to grains and grasses, and excellent yields are obtained. Owing to its rough topography, however, it is probably best used for pasturage.

Berks shale loam.—The soil is a heavy loam or silt loam from 6 to 10 inches deep, ranging in color from brown to yellowish brown with occasional spots of red. It contains from 40 to 70 per cent of shale fragments. The subsoil is usually a heavy silty loam, or silty clay loam, generally lighter in color than the surface soil, and containing a large quantity of shale fragments. The type is underlain by unbroken shale at depths ranging from 18 inches to 5 feet. The topography ranges from "billowy" to moderately rolling, with well-rounded tops of hills and ridges rising from 50 to 100 feet higher than the limestone valleys. Liability to erosion necessitates careful preventive measures. This soil is adapted to general farming, except that crops are subject to injury from drought where the soil is shallow. Potatoes do especially well, and the type includes many areas well adapted to the production of apples, peaches, and small fruits. The yields are: Corn 20 to 60 bushels, wheat 15 to 30 bushels, oats 25 to 50 bushels, potatoes 125 to 250 bushels, and hay 1¼ tons per acre.

Chemung shale loam.—This soil is a chocolate-colored fine loam, averaging about 8 inches deep and carrying dark chocolate-colored shale chips or fragments of varying thickness. The subsoil is usually similar in color and texture to the soil, though sometimes it is a little lighter both in color and texture. In some places platy fragments of the chocolate-colored parent rock, from about 6 to 24 inches in diameter, must be removed before cultivation is practicable. The surface is rough or rolling and the drainage is excellent. The type is derived from the weathering of the slates of the Chemung formation. Little of this soil is under cultivation, but it could be made fairly productive for the general farm crops and possibly for fruit. It is locally known as "black slate land."

Conasauga shale loam.—The soil to a depth of 6 to 9 inches is a gray to brownish silt loam or very fine sandy loam, containing numerous shaly sandstone and soft shale fragments. The subsoil varies from a yellowish heavy silt loam to a light-brown silty clay. The shale content increases with depth and gradually gives way to solid rock. In numerous small areas both the soil and subsoil represent little more than a mass of soft shale, varying from green to yellowish-brown in color. The type occupies undulating to gently rolling valley areas. It is of residual origin, being derived from fine-

grained sandy shales interstratified with thin layers of sandstone. The greater part of the type is forested with pine, chestnut, and oak. Small areas are cultivated to corn, which is the principal crop. The soil is adapted to fruit growing.

Dekalb shale loam.—The soil to an average depth of about 8 inches consists of a brown to yellowish loam or clay loam. This is underlain by yellowish clay loam which increases in clay content with depth. A mass of broken shale fragments is generally encountered at less than 24 inches. On the surface and throughout the soil and subsoil are scattered varying quantities of weathered shale fragments, the content usually increasing with depth. The surface features consist of smooth, rounded knobs and ridges, with narrow intervening valleys. The type is of residual origin and is derived from arenaceous and argillaceous shales. The soil is rather droughty. It is best adapted to grain and grass crops.

Lickdale shale loam.—The soil is a gray to light-brown silt loam averaging about 6 inches in depth. The subsoil is a yellow silty clay mottled with gray and dull bluish colors in the lower portion. At about 12 to 24 inches the parent shale rock is encountered. Fragments of the gray, olive, bluish, and brown shales are numerous over the surface and throughout the soil mass. The type occupies lower slopes, usually bordering streams or terrace soils. It is kept in a soggy condition by seepage a good part of the year, but is liable to excessive drainage in dry periods. Little of the type is used for agriculture. Chestnut, oak, hickory, and pine constitute the principal growth. Grasses, such as redtop and meadow fescue, do well. The soil is well suited to lespedeza.

Montevallo shale loam.—To a depth of about 6 inches the soil is a purplish or brownish, floury silty loam containing some fine sand. The subsoil is a purplish, Indian-red, or highly variegated silty or clay loam, often resting upon the parent rock at about 2 feet. The type is derived from the variegated, usually fine-grained to slightly sandy shales of the Montevallo formation of Cambrian age. The topography is rolling to hilly and sometimes mountainous and ridgy with steep slopes. On the more level or gently sloping areas some of the type is cultivated, though for the most part it is better adapted to forestry and grazing.

Upshur shale loam.—The soil is an Indian-red rather loose loam about 6 to 8 inches deep. The subsoil is somewhat heavier in texture and of a deeper Indian-red color than the soil. The type carries large quantities of red-shale fragments on the surface and through the soil, which increase in amount with depth. Bedrock is usually encountered at about 18 to 20 inches. This type is derived from alternating red shales and sandstones. It occupies comparatively broad ridges and hills with steep slopes. The drainage is well established to excessive. General farm crops, fruits, and soy beans do well. Alfalfa has been successfully grown.

Area and distribution of the soils of the shale loams.

Soil name.	State or area.[1]	Acres.
Dekalb shale loam	Alabama 6, 11, 15, 21, 37; Kentucky 2, 4; Maryland 7; Pennsylvania 2, 5, 6, 8, 9, 10, 11, 12; Tennessee 4, 5; Virginia 1, 3, 7.	1,067,700
Berks shale loam	Pennsylvania 3	172,800
Upshur shale loam	Pennsylvania 2	70,656
Montevallo shale loam	Alabama 3, 6, 8; Georgia 18	26,944
Conasauga shale loam	Georgia 18; Tennessee 4	22,464
Lickdale shale loam	Kentucky 4	20,416
Allis shale loam	New York 9, 17	13,248
Chemung shale loam	Pennsylvania 2, 8	5,376
Total		1,399,604

[1] For key to numbers in this column see p. 733.

SLATE-LOAM PHASE.

The soil of the slate-loam grade has been confined to a single type in the areas so far mapped, the Talladega slate loam. This type is extensively developed in the southern Appalachians. The topography is prevailingly rough or steeply sloping, and its agricultural value is rather low. The small grains and grass give fairly good returns in the smoother areas.

Talladega slate loam.—The soil consists of about 4 inches of slaty, dark-gray or light-brown silt loam. The subsoil is a shaly, dark-red clay loam or clay to a depth of about 20 inches, where a fragmentary rock mass is generally reached. Both soil and subsoil have a decidedly soapy or greasy feel imparted by mica and small, partially decom-

posed schist fragments. Large and small fragments of micaceous schist and quartz are scattered over the surface and throughout the soil mass. The topography is rough and mountainous and the drainage is rapid. The type is subject to destructive erosion. The soil is residual, and is derived from micaceous and talcoid schists carrying veins of quartz and quartzite. It is best adapted to forestry, though cereals and grasses do fairly well on the smoother areas. Corn and cotton give small yields.

Area and distribution of the soil of the slate loam.

Soil name.	State or area.[1]	Acres.
Talladega slate loam	Alabama 6, 35	115,584

[1] For key to numbers in this column see p. 733.

BLACK LOAM PHASE.

A single type of the black loam has been mapped in the Blue Ridge belt of the southern Appalachian Mountains, the Porters black loam. The soil owes its characteristic dark surface color to the accumulation of considerable vegetable matter. The type is developed in coves and along smoother slopes which favor the retention of vegetable matter. Aside from its mellow structure and high organic content, it is essentially similar to the loam type of the Porters series, with which it is closely associated in occurrence. This soil is especially well suited to certain varieties of apples.

Porters black loam.—The soil is a rich, dark loam about 15 inches deep, mixed with rounded and angular fragments of rock, often several feet in diameter. The subsoil is a yellowish-brown or reddish-brown to red clay loam containing a large percentage of rock. The type occupies the gentle slopes and coves. It is of residual origin, being derived from granite, gneiss, and associated rocks. The soil is productive, but the slopes are often too steep and stony to admit of extensive cultivation for general farm crops. It is especially adapted to apples, particularly the "Albemarle pippin." For this fruit the small coves on the eastern slopes of the mountains are considered most desirable. Where exposed on the mountain tops it has little value for fruit and is used only for grazing.

Area and distribution of the soil of the black loam.

Soil name.	State or area.[1]	Acres.
Porters black loam	North Carolina 2, 13, 14, 18, 27; Virginia 1, 3	193,550

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loams are widely developed throughout the Appalachian plateaus and the Appalachian Ridge. The greater part of the group is included in one type, the Dekalb silt loam. The topography has a wide range, varying from flat plateaus to steep slopes. The soils are derived from shales and fine-grained sandstones, with some limestone or calcareous shale influence in certain series, like the Westmoreland, Palatine, and Upshur.

The general farm crops, small grain, corn, and grass give good results. Aside from late cabbage, tomatoes, and Irish potatoes, vegetables are of little importance except for home use and market gardening in favored localities near cities. Some varieties of apples do well, and grapes can be successfully grown.

The soils of the silt loam group have a tendency to harden in dry weather, which necessitates the employment of heavy implements and draft animals in its cultivation. Applications of lime, liberal incorporation of organic matter, and moderately heavy fertilization are required for the maintenance of good yields on most of the types.

The Westmoreland, Upshur, and Palatine series are naturally more productive than the straight shale and sandstone types represented by the Dekalb and Hanceville series. Where the topography is favorable those types which contain residual material from calcareous rocks give moderate to heavy yields of the general farm crops. Por-

tions of the Dekalb and Hanceville types are too steeply sloping and susceptible to erosion for safe cultivation.

Allis silt loam.—The surface soil of the Allis silt loam consists of 8 to 10 inches of light-brown to gray silt loam, containing small amounts of rounded gravel and soft shale fragments. This overlies a subsoil of gray, sticky, silty loam or clay loam. The surface soil is friable, and cultivation is carried on without much difficulty. The topography is level to undulating, though drainage is usually poor on account of the heavy character of the subsoil. The soil is derived from the intermixture of glacial material of foreign origin with residual material formed through the weathering of the soft shales of the Salina formation. Most of the previously existing glacial drift has been removed through glacial stream erosion. The type is adapted to corn, oats, wheat, and hay.

Berks silt loam.—The soil to an average depth of 10 inches is a brown or yellowish-brown silt loam or heavy silty loam, with a subsoil of heavy yellow silt loam which grades into a silty clay loam at 16 to 20 inches. This rests upon undecomposed shale at depths ranging from 30 inches to 4 feet. A few shale fragments are found on the surface, and sometimes constitute 10 to 25 per cent of the subsoil mass. The material is derived from the Hudson River shales. The surface is level to gently rolling. The soil is adapted to general farming. The average yields are: Corn, 45 bushels; oats, 40 bushels; wheat, 22 bushels; and hay, 1½ tons an acre.

Colyer silt loam.—The surface soil to a depth of 8 to 10 inches is a silt loam of loose, friable texture and yellow to yellowish-brown color. The subsoil is a yellow, heavy, very silty clay loam, which at depths of from 24 to 40 inches rests on soft, black carbonaceous shale. The soil has a tendency to bake somewhat after rains, but crumbles readily under cultivation. Locally the type is known as "soapstone land." It is considered a good soil. The type occupies small areas along the foot of mountain slopes. The surface is rolling and includes rounded hills. Surface drainage is well developed, and during long dry seasons crops suffer from drought. The soil is derived from soft carbonaceous shales, beds of which lie between the limestone formation and the thin-bedded shales giving rise to the Dekalb shale loam type. It produces good yields of the general farm crops.

Conasauga silt loam.—The soil is a light-brown silt loam, and the subsoil is a yellow silty clay loam to silty clay. The type occurs as level to gently rolling valley lands and is derived from shales of the Conasauga formation or similar rocks. Under proper management good yields of corn, oats, wheat, grass, and forage crops are secured. Cotton does fairly well.

Conway silt loam.—The soil is a yellow to gray, close-structured silt loam about 6 inches deep. The subsoil material is similar in texture, but has a yellow to nearly white color, depending on drainage conditions. Both soil and subsoil carry iron concretions and in some places an iron hardpan exists in the subsoil. Numerous mounds 10 to 15 feet in diameter and 2 to 6 feet high occur over the type. The soil is developed both on uplands and in close proximity to streams. Most areas are low and wet, have a gently rolling to flat surface, and are usually surrounded by higher land, the drainage waters from which pass over this soil, producing conditions of poor drainage. Large areas must be ditched to facilitate cultivation. Some of the type appears to be a true second bottom, while the upland proper is a residual soil from shales. A large part of the type supports the virgin growth of oaks and lowland grasses, and under cultivation produces only indifferent yields of corn and cotton. Heavy liming and improvement of physical conditions are the principal needs of the soil.

Dekalb silt loam.—The soil is a mellow silt loam of gray to yellowish color, ranging from about 8 to 20 inches in depth. The line of demarcation between soil and subsoil is not sharply defined. The subsoil is a friable or brittle silty clay loam. Its characteristic yellowish color is lighter than that of the soil. Nearly everywhere fragments of shale or shaly sandstone are scattered through the soil and over the surface. Bedrock is often encountered at a depth of less than 3 feet. The type occupies rolling and hilly uplands and more broken areas near streams. The soil is fairly retentive of moisture. With the usual rainfall of the region crops seldom suffer seriously from drought. The tendency to wash and gully is not so great as in many soils of similar topography, yet the steep hillsides should not be planted to cultivated crops. The soil is residual, formed by the decomposition of the shales, fine-grained sandstones, and sandy shales, principally of the Carboniferous period. Corn, wheat, and timothy are the most important cultivated crops. Much of the hilly and stony land is unfit for cultivation, but is well adapted to grasses. In the extremely rough portions the land is still in forests of hardwood. Crops are markedly benefited by applications of lime, vegetable matter, and commercial fertilizers.

Hanceville silt loam.—The soil is a pale-yellowish to reddish-brown silt loam about 5 to 10 inches deep. The subsoil is a yellowish-red to red silty clay loam, passing at lower depths into silty clay. The topography is steeply sloping to mountainous, with

some smoother areas on the crests of ridges and on gentle slopes. The type is derived from shales and sandstone. It is fairly well suited to the production of small grains, grass, and Irish potatoes.

Palatine silt loam.—The soil of the Palatine silt loam to a depth of from 12 to 18 inches is a dark-brown silt loam, black when wet. It has a granular structure. The subsoil to an average depth of 30 inches is a dark-colored silty loam, grading into a clay loam. At a depth of 36 to 60 inches the subsoil rests on the black calcareous shales from which it is derived. The topography is rolling to somewhat hilly and surface and subsoil drainage are good. It is a strong soil for corn, clover, and grass. Alfalfa can be successfully grown. Potatoes yield well. Oats give fair yields.

Upshur silt loam.—The soil to a depth of 8 to 15 inches is a purplish-gray or Indian-red silt loam. The subsoil is a heavy, purplish-red, compact silt loam grading into a reddish-brown silty clay which gives way to decomposing shales of reddish to yellow color. The quantity of rotten shale fragments increases from the surface down. Many sandstone fragments occur in some localities. The type occupies rounded hills and ridges with more or less broken surface, and drainage is always good. It is derived from red sandstones, shales, and sandy shales of Paleozoic age. The timber growth is scrubby hardwood with some pine. Cultivated areas give only fair yields of corn, wheat, and hay.

Westmoreland silt loam.—The soil is a grayish-brown to brown mellow silt loam about 7 to 12 inches deep. The subsoil is yellowish-brown to yellow silty clay loam to silty clay, usually becoming heavier in texture and lighter in color with increasing depth. The type is derived from shales and fine-grained sandstone with interbedded limestone and calcareous shales. The topography ranges from rolling to quite steep, many areas being so sloping that plowing enhances the danger of erosion. In the main the soil has excellent drainage and is sufficiently retentive of moisture to meet the requirements of plants during drought. The principal trees of forested areas are oak, hickory, locust, black gum, maple, and beech. The type is admirably suited to the production of corn, oats, wheat, grass, potatoes, apples, peaches, plums, cherries, and berries.

Area and distribution of the soils of the silt loams.

Soil name.	State or area.[1]	Acres.
Dekalb silt loam	Alabama 10, 15, 21, 28, 35, 37; Indiana 9; Kentucky 2, 4, 7; Ohio 5, 6; Pennsylvania 2, 5, 8; Tennessee 4, 5, 10; Virginia 9; West Virginia 1, 2, 4, 5, 6, 7, 8, 10.	1,320,256
Westmoreland silt loam	Pennsylvania 2, 18	492,544
Hanceville silt loam	Alabama 37	95,168
Conway silt loam	Arkansas 1	38,912
Berks silt loam	Pennsylvania 3	17,600
Conasauga silt loam	Georgia 18	11,584
Colyer silt loam	Kentucky 4; Pennsylvania 5, 15	9,984
Upshur silt loam	Virginia 9; West Virginia 1	4,672
Palatine silt loam	New York 11	3,840
Allis silt loam	New York 13	384
Total		1,994,944

[1] For key to numbers in this column see p. 733.

STONY SILT LOAM PHASE.

The only representative of the stony silt loam phase so far encountered in the Appalachian province is the member of the Dekalb series. It differs from the Dekalb silt loam merely in the presence of cumbersome rock fragments, which in places make cultivation difficult. The crop adaptation is the same, and the productivity practically the same as that of the silt loam. Much of the stony silt loam is too inaccessible and difficult to work for profitable returns and is suited only to pasturage, fruit growing, or forestry.

Dekalb stony silt loam.—The soil to a depth of about 6 inches is a light-brown to pale-yellowish silt loam. The subsoil is a pale-yellow heavy silt loam, sometimes changing in the lower portion into a silty clay loam or silty clay. In places, especially on the lower slopes, the subsoil is mottled yellow and gray. Usually on the tops and upper slopes of ridges it is difficult to bore with the soil auger deeper than about 2 feet on account of the broken stone. There are, however, large quantities of interstitial soil material above the bedrock.

Along the boundary between this type and the Dekalb shale loam there is a greater proportion of shale fragments, and it is often difficult to find a sharp line of separation.

On slopes the larger rock fragments are more numerous, the quantity being sufficient to interfere with cultivation. The type occupies hills, irregularly developed ridges, and steep slopes. It is derived from thin-bedded shales and fine-grained sandstones. Erosion is quite active in places. Much of this land is timbered with pine, oak, chestnut, and hemlock, yet the type also includes many large farms. The yields of the general farm crops, corn, wheat, oats, and grass are fair. Oats do better than on the Dekalb shale loam. Clover does exceptionally well with the use of lime. Certain varieties of apples can be successfully grown.

Area and distribution of the soil of the stony silt loam.

Soil name.	State or area.[1]	Acres.
Dekalb stony silt loam........	Alabama 15; Pennsylvania 2, 5; West Virginia 2...............	344,640

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

A large area is occupied by the clay loam group, particularly the Meigs clay loam, which has an extensive development in the severely eroded portions of the Allegheny Plateau in West Virginia and eastern Ohio. The other members of the group so far encountered are not widely developed.

The clay loams of the Appalachian province have been largely derived from shales and fine-grained sandstones, with some influence from medium-textured sandstones and calcareous shales. The Porters member of the group is derived from schist, granite, gneiss, and other crystallines of the Blue Ridge region. Considerable areas now included with the clay loam group originally had surface soils of a silt loam or other textural grade, the clay loam condition having been brought about by the removal of the surface layer, or a portion of the surface layer, by erosion in such manner as to bring the heavier subsoil material into the surface stratum.

The soils of the clay loam group are even more difficult to keep in a good condition of tilth than the silt loams, and they are considerably more susceptible to erosion. The steeper slopes include large areas which can not be plowed, solely because of the danger of destructive erosion, and which are suited only to grazing, forestry, and the production of fruits. Heavy tools and stock are necessary for the proper cultivation of these soils. Applications of lime, the frequent incorporation of organic matter, and the growing of winter cover crops are commendable practices in the utilization of most of these lands.

The clay loams are best suited to the general farm crops, especially hay, clover, wheat, oats, rye, and corn. Varieties of apples, grapes, and peaches do well on some of the types. Little success may be expected with the production of vegetables.

The Lickdale clay loam occupies areas adjoining the lower slopes where drainage conditions are rendered imperfect by the accumulation of seepage waters. The Meigs clay loam is quite variable; it really represents an intricate association of two or more types.

Dekalb clay loam.—The soil to a depth of 8 to 10 inches is a drab to pale-yellow heavy silt loam or silty clay loam. The subsoil consists of a pale-yellow heavy silty clay loam, which generally grades into a yellow, rather plastic silty clay, slightly mottled with reddish-drab and brown colors. The type occurs on the gentler or lower slopes. It is derived from the weathering of shales and slate. Some of the finer material of the soil has been washed down from above. The type is deficient in lime. It is somewhat cold natured and rather poorly drained in places. Cereals and grass give good results.

Lickdale clay loam.—This type includes a clay loam 6 to 10 inches deep, underlain by a mottled yellow clay. It occurs in small areas along foot slopes and is derived from the underlying shales. It carries surface accumulations of colluvial material. Sometimes fragments of shale and sandstones are present to the extent of from 5 to 20 per cent. The type has a sloping to nearly flat surface and is poorly drained. It is naturally refractory and suited only to grass and pasture, but when artificially drained and limed it becomes mellow and produces a variety of crops.

Meigs clay loam.—The soil is a grayish-brown to Indian-red silt loam to clay loam, varying in depth from 2 to 7 inches. Over the surface and throughout the soil fragments of grayish shale or shaly sandstone are often found. The subsoil is generally a compact but friable yellowish or reddish silt loam or clay loam. At 10 to 20 inches it usually grades into a brittle clay, which extends to a depth of more than 3 feet and

generally has a red, yellowish, or mottled yellowish-red and yellow color. Fragments of shale and shaly sandstone occur through the subsoil. Shale rock is often found at depths varying from 2 to 3 feet. This type really includes both the Dekalb and Upshur clay loam, together with some silt loam, so intricately involved as to preclude any practical separation. The topography of the type is, in general, hilly and rough, but some comparatively small areas occupy well-rounded hilltops. The soil is derived from the shales and sandstones of both the upper and lower Coal Measures. A small part of the type is cultivated. It is not naturally a strong soil, but fairly good yields are obtained by the use of fertilizers. The principal crops are corn, wheat, and hay. The greater part of the type is best adapted to pasture.

Morrison clay loam.—The soil to a depth of 6 to 8 inches is a brown or yellowish-brown silty clay loam. The subsoil is a reddish-yellow friable clay loam to clay. This type occupies rolling areas in the "barrens" and along the line between the barrens and the limestone soils. It is derived largely from sandstones, with possibly some admixture of material from limestone near the boundaries of the soils derived from limestone. The type is largely timbered.

Porters clay loam.—The soil varies from 3 to 5 inches deep. Where the surface is rolling the soil is a brown silt loam, and in areas of broken and rough surface it consists of a reddish-brown clay loam. Along some of the streams the surface is very broken, rock outcrops occur, and fragments of rock are scattered over the surface. The subsoil is a reddish clay loam or clay. The surface features vary from rolling to rough and mountainous, and the drainage is good. The type is derived from granites, gneisses, and schists. Fair yields of corn, sorghum, and other crops are produced in those locations where the topography permits cultivation. Where the surface is broken and mountainous the land should remain in forest.

Area and distribution of the soils of the clay loams.

Soil name.	State or area.[1]	Acres.
Meigs clay loam	Ohio 6; West Virginia 1, 2, 4, 5, 6, 7, 8	2,642,944
Lickdale clay loam	Pennsylvania 2, 3, 6, 8, 10, 11, 12; Tennessee 11	42,000
Porters clay loam	South Carolina 13	26,432
Dekalb clay loam	Pennsylvania 5	15,488
Morrison clay loam	...do	1,280
Total		2,728,144

[1] For key to numbers in this column see p. 734.

SILTY CLAY LOAM PHASE.

The soils of the silty clay loam grade comprise a relatively small area and have a scattered occurrence through those portions of the Appalachian Mountains and Plateaus province occupied by shaly and fine-grained sandstone rocks. They differ essentially from the clay loam group in their high content of silt and slightly easier working qualities. They are adapted to about the same crops as the clay loams and may be expected to give very nearly the same yields. The general farm crops of the region and fruit give the best returns. The soils require thorough tillage and liberal addition of vegetable matter to prevent the land from assuming a compact structure.

The Upshur and Westmoreland silty clay loams carry a moderate amount of material derived from calcareous shales and limestone, as a result of which these types are more productive and durable than soils like the Dekalb silty clay loam, which is composed of pure shale and fine-grained sandstone material.

Armuchee silty clay loam.—The soil is a brown to reddish-brown silty clay loam about 4 to 6 inches deep. The subsoil is a red silty clay. The type occupies undulating, moderately rolling valley lands. It is derived largely from interbedded fine-grained sandstone and shales, with occasionally some limestone. It is well suited to corn, grain, and forage crops.

Dekalb silty clay loam.—The soil is a light-brown to yellowish-brown heavy silt loam to silty clay loam about 4 to 8 inches deep. The subsoil is a compact, brittle, yellow silty clay loam to silty clay. On the steeper slopes fragments of the parent fine-grained sandstone and shale occur in the soil. The type occupies gentle to steep slopes, the crests of ridges, and the tops of hills. Grass gives only moderate returns. Corn and small grains do fairly well, and certain varieties of apples are fairly productive.

Upshur silty clay loam.—The soil is a grayish-brown to light-red silty clay loam, about 8 to 12 inches deep. The subsoil is a heavy, red silty clay loam to silty clay, which at a depth of about 24 inches grades into an Indian-red, heavy, plastic clay. While the surface color is often grayish, the subsoil has the typical red color of the Upshur series. The type is developed mainly on comparatively low hills, the topography being somewhat less rolling than that of the Upshur clay. The soil is derived from red shales and fine-grained sandstone with some gray shales. It is suited to apples, bluegrass, corn, and wheat. Yields are not quite so heavy as those secured from the Upshur clay, but are considerably better than those from the Dekalb silt loam. A number of vegetables can be grown with fair success.

Westmoreland silty clay loam.—The soil is a grayish-brown to light-brown silty clay loam, about 4 to 10 inches deep. The subsoil is a yellow silty clay loam which quickly grades into a yellow silty clay of a somewhat sticky, plastic structure, and sometimes an olive-green color in the lower portion, especially when in contact with underlying limestone. Where the type overlies limestone the texture averages heavier. Those areas derived mainly from the limestone and not markedly influenced by material from the associated shales and sandstones really represent local developments of the Brooke soils. The typical soil is derived from interbedded fine-grained sandstone, shale, and limestone. It occupies smooth slopes principally and has excellent drainage. The type is a valuable soil, suited to corn, small grains, bluegrass, timothy, and clover. A great part of it is used for bluegrass pasturing and affords excellent grazing.

Area and distribution of the soils of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Dekalb silty clay loam	West Virginia 1, 5	259,968
Westmoreland silty clay loam	do	166,080
Upshur silty clay loam	West Virginia 7	20,288
Armuchee silty clay loam	Georgia 18	6,016
Total		452,352

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The clays comprise a moderate area in the Appalachian province. A large part of the area represents valuable agricultural land capable under proper management of producing heavy yields of the general farm crops. Certain types are particularly well adapted to peaches. These are the heaviest textured soils of the province and are the most difficult to maintain in a proper state of cultivation. They require heavy draft animals, strong implements, and frequent tillage. There are many slopes, which, owing to the susceptibility of the soil to erosion, are too steep for safe cultivation and which should be used only for pasturage, forestry, and fruit growing. Winter cover crops should be grown on all cultivated areas having sufficient slope to be subject to erosion.

The Porters clay is widely developed in scattered areas throughout the Blue Ridge Mountains and the intermontane region of the broad Blue Ridge belt in North Carolina and Georgia. It is a valuable soil, well suited to certain varieties of apples, and capable of producing good returns with general farm crops on the smoother areas. The Dekalb clay embraces a moderate area in the plateaus and on the ridges and mountains between the Appalachian Plateau and the Blue Ridge division. It is a much less productive soil than the Porters or the Upshur clay. The Upshur clay is confined principally to the ridges and plateaus of the northern division of the province. It is an excellent peach soil, and when properly cultivated gives rather heavy yields of the general farm crops.

Allis clay.—The soil consists of a gray or olive colored silty clay or clay loam to an average depth of about 8 inches. The subsoil is a silty clay or clay, slightly heavier than the soil and lighter in color, sometimes being a mottled gray. There is no distinct dividing line between the soil and subsoil, and the latter often passes into bedrock in the lower part of the section. The topography of the type varies from level to steeply rolling. The soil is residual in origin, being formed from the weathering of the light-colored Salina shales. Sometimes there are a few glacial stones at the surface, but no considerable quantity of other glacial material. The soil is adapted to

general farm crops and to dairy farming. Corn, oats, and hay are the principal crops grown, and all do well. Wheat is not extensively grown, but gives fair yields.

Conasauga clay.—The soil of this type to a depth of 6 or 8 inches is a light grayish yellow silt containing considerable clay. The subsoil is a heavy clay of pale-yellow color. The type occupies rather flat valley areas, which are locally known as the "flatwoods." The soil is derived from the Coosa flatwoods shales and the Conasauga shales of Cambrian age, this formation consisting of nearly vertically disposed shales interstratified with seams of limestone varying from less than an inch to several feet in thickness. The larger part of the material is derived from the shales, and the soil is quite similar in general appearance to that derived from the finer grained sandstone and shales of the Coal Measures as seen in the Dekalb series. The agricultural value is about the same as that of the finer textured members of the Dekalb series.

Dekalb clay.—The soil consists of about 8 inches of grayish-brown loam or clay loam, containing silt often in large amounts. This is underlain to a depth of 36 inches or more by a yellow or yellowish-brown clay. Both soil and subsoil usually contain from 10 to 40 per cent of small shale fragments. The usual topography of the type is hilly and the natural drainage is good. The soil is derived from the weathering of shales belonging largely to the Coal Measures. It supports a timber growth consisting mainly of oak, hickory, beech, and pine. When cleared and cultivated fair yields of cotton, corn, vegetables, sorghum, and forage crops are secured. The higher ridges are suited to peaches and other orchard fruits.

Porters clay.—The soil is a reddish-brown to red clay loam about 6 inches deep. The subsoil is a stiff red clay to a depth of 20 inches or more. Both soil and subsoil contain a large quantity of stone. The type occupies mountain slopes. The soil is residual, and is derived from granite, gneiss, and other crystalline rocks. When not too stony and rough for cultivation it produces good crops of corn, wheat, and grass. It is one of the important apple soils of the mountains.

Upshur clay.—The type consists of a stiff Indian-red clay about 7 inches deep, underlain by an Indian-red clay of nearly the same texture. The soil occupies rolling uplands and slopes, and occasionally extends down into the valleys. It is susceptible to severe erosion. Exposed areas are inclined to bake and crack in dry weather. The type is the direct product of the weathering of shales. It is mainly used for pasturage, but the more gently rolling areas, favorable to thorough cultivation, produce good crops of wheat, corn, and grass.

Area and distribution of the soils of the clays.

Soil name.	State or area.[1]	Acres.
Porters clay	North Carolina 2, 13, 14, 18, 27; Pennsylvania 1; South Carolina 3, 13; Virginia 1, 3, 7; West Virginia 3.	292,509
Upshur clay	New York 9, 14; Ohio 6; West Virginia 1, 4, 6, 7, 8, 9, 10	256,000
Dekalb clay	Alabama 4, 27; Ohio 3; Pennsylvania 8; West Virginia 9	131,520
Conasauga clay	Alabama 6, 15, 21	64,768
Allis clay	New York 9, 10	3,008
Total		747,805

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

Allis silty clay.—The type is a brown, drab, or grayish-brown silty clay soil about 9 inches deep. This overlies a gray, dark, bluish gray, or mottled, heavy silty clay loam or silty clay subsoil. A rather large amount of thin shale chips are present in the soil and subsoil. At about 3 feet the subsoil grades into the soft shale rock. The topography is rolling to hilly, and the natural surface drainage good. On account of the heavy character of the material and the proximity of the shale rock, the subsoil is insufficiently drained. Corn for silage, oats, rye, hay, and peas are the principal products.

Area and distribution of the soil of the silty clay.

Soil name.	State or area.[1]	Acres.
Allis silty clay	New York 5	4,032

[1] For key to number in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough stony land	Alabama 3, 6, 11, 15, 21, 22, 27, 28, 35; Arkansas 1, 2; Georgia 18; Kentucky 2, 4, 7; New Hampshire 2; Ohio 6; Pennsylvania 1, 2, 3, 5, 8, 18; Tennessee 4, 10; Virginia 9; West Virginia 1, 2, 4, 5, 6, 7, 8, 9, 10.	1,602,048
Steep broken land	Pennsylvania 8, 18; West Virginia 10	107,008
Rock outcrop	Alabama 21; Kentucky 4; New York 6; North Carolina 2, 13, 18, 27; South Carolina 3; Tennessee 11; Virginia 3.	55,873
Muck and swamp	Pennsylvania 13	10,368
Made land	Pennsylvania 5	448
Total		1,775,745

[1] For key to numbers in this column see p. 733.

Revision of September, 1912.

Key to the Soils of the Appalachian Mountain and Plateau Province.

- Sandstone and shale
  - Purplish red variegated soil
    - Reddish brown subsoil
      - Sandstone highly ferruginous
        - Red clay shale and sandstone substratum
          - Montevallo
  - Indian red soil
    - Indian red subsoil
      - Upshur
  - Brown soil
    - Yellow compact friable subsoil
      - Substratum yellow and red clay (mixed Upshur and Dekalb material)
        - Meigs
    - Reddish brown subsoil
      - Fayetteville
  - Reddish brown soil
    - Brick red subsoil
      - Hanceville
  - Yellowish gray soil
    - Yellow subsoil
      - Dekalb
  - Gray soil
    - Light gray subsoil
      - Warren
    - Yellowish subsoil
      - Colluvial material
        - Drainage well established
          - Jefferson
    - Mottled yellow gray and bluish subsoil
      - Drainage poorly established
        - Lickdale
  - Dark brown soil
    - brown subsoil
      - Conglomerate
        - Substratum heavy reddish brown clay
          - Paris
- Sandstone and quartzite
  - Grayish yellow soil
    - Yellow subsoil
      - Substratum red clay
        - "Barrens"
          - Morrison
- Shale and sandstone with some interbedded limestone
  - Gray soil
    - Yellow heavy clay subsoil
      - Conasauga
  - Brown soil
    - Red subsoil
      - Armuchee
    - Yellow friable subsoil
      - Sloping to rolling topography
        - Westmoreland
- Sandstone shale and limestone
  - Brown soil
    - Red subsoil
      - Mixed Dekalb and Decatur material
        - Aller
- Black shale
  - Black soil
    - Black subsoil
      - Substratum calcareous shale
        - Palatine
  - Yellow soil
    - Yellow intractable subsoil
      - Substratum shale
        - Colyer
- Chocolate brown shale
  - Chocolate brown soil
    - Chocolate brown subsoil
      - Chemung
- Brown shale
  - Brown soil
    - Yellow subsoil
      - Shale indurated
        - Berks
    - Light brown subsoil
      - Substratum shale
        - Allis
  - Yellow soil
    - Yellow and white subsoil
      - Iron concretions and iron hardpan
        - Drainage poorly established
          - Conway
- Igneous and metamorphic rocks
  - Granite and gneiss
    - Gray and red soil
      - Red subsoil
        - Porters
  - Taloose mica schist and imperfectly crystalline slates
    - Brown soil of greasy feel
      - Yellow subsoil
        - Chandler
      - Red subsoil
        - Talladega

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SOILS OF THE LIMESTONE VALLEYS AND UPLANDS PROVINCE.

By Hugh H. Bennett.

DESCRIPTION OF THE PROVINCE.

BOUNDARIES.

The Limestone Valleys and Uplands province includes two important topographic divisions—the limestone valleys and the limestone uplands. The boundaries of these divisions are generally sharply defined, although in some places they merge rather imperceptibly into each other.

The limestone valleys are most extensively developed within the Appalachian Mountain region. The main valley follows the eastern border of the great central division of the Appalachian system, with the Blue Ridge as its eastern boundary and the Appalachian ridges and Allegheny Plateau on the west, extending from Alabama to New Jersey. It crosses Tennessee as a broad belt, ranging in width from 40 to 60 miles. This broader portion is known as the Valley of Eastern Tennessee and lies between the Blue Ridge Mountains on the east and the Allegheny-Cumberland Plateau on the west. In southern Virginia the valley narrows, continuing northward and varying in width from 8 to 20 miles. It is known as the Shenandoah Valley in Virginia, Cumberland Valley in Maryland and southern Pennsylvania, and Lebanon Valley in eastern Pennsylvania. The Georgia and Alabama extension is broken into several valleys by detached portions of the Cumberland Plateau and Taylors Ridge. These are known as Coosa, Chattooga, and Wills Valleys.

The portion of this physiographic belt extending northward from New Jersey through New York has been glaciated and is therefore included in another soil province.

A number of detached valleys of varying size, conforming with the general northeast and southwest direction followed by the main valley, occur within the Appalachian Ridge belt. As defined in this report, the belt includes the long, narrow ridges and intervening lowlands lying west of the main limestone valley, with the Allegheny Front on the west. The Nittany Valley of Pennsylvania is the most important of these. Among the others are the Sequatchie Valley of Tennessee and those in the vicinity of Frederick, Md., and of York and Lancaster in Pennsylvania. The Sequatchie Valley, with its Alabama extension, known as Browns Valley, lies within the Cumberland Plateau, being separated from the major valley to the east by a fairly wide strip of plateau land. The remaining smaller valleys lie within the Piedmont Plateau, east of the Appalachian Mountains.

Two large areas not closely associated with the valley belt of the Appalachian region, but included in the valley division of the province, are the Central Basin of Tennessee and the Bluegrass region of Kentucky. The Central Basin embraces several thousand square miles in central Tennessee, while the Bluegrass region of central and northern Kentucky is about 100 miles across from east to west and 125 miles from north to south. The boundaries of these basin regions are very irregular, although more or less circular in outline.

The uplands division of the Limestone Valleys and Uplands province includes a large area comprising (1) the Highland Rim region of northern Alabama and central Tennessee, continuing through Kentucky nearly to the Ohio River, and (2) the Ozark Dome of southern Missouri, northern Arkansas, northeastern Oklahoma, and southeastern Kansas.

The Highland Rim division is bounded on the east and south by the Cumberland Plateau, on the west by the Cumberland River in Tennessee and southwestern Kentucky, and on the north by the western coal fields, the Bluegrass region of Kentucky, and the Ohio River. In Tennessee the Highland Rim completely surrounds the Central Basin. The corresponding basin of Kentucky, the Bluegrass region, is bounded on the south and in part on the east and west by the Kentucky extension of the rim. Northwest and north lies the glaciated country of Ohio.

The Ozark Dome is bounded on the south by the Boston Mountain Plateau, on the north by the Missouri River, on the west and northwest by the Great Plains region, and on the east by the Mississippi River and its bottoms. It embraces a considerable strip of northern Arkansas, a rather small area in northeastern Oklahoma, and a very small part of the southwestern corner of Kansas and a large area of southern Missouri.

PHYSIOGRAPHY AND GEOLOGY OF THE LIMESTONE VALLEYS.

The limestone valleys of the Appalachian region owe their topographic features to the structure and composition of the regional rocks. They are lowland belts developed by the rapid weathering of soft rocks, rather than valleys produced by the leveling action of streams in the development of flood plains. Subsequently to the intense folding which the rocks of the region have undergone, weathering has affected the surface unequally, owing to the varying resistance to erosion offered by the upturned edges of sandstones, conglomerates, shales, and limestones. The sandstones and conglomerates have resisted the agencies of weathering much better than the soft limestones and shales, and consequently have been left as ridges. The limestones and shales, being composed of less resistant material, have decayed more rapidly, with the result that the surface of the areas occupied by these rocks is now much lower than that of the areas occupied by the more resistant rocks.

The topography of the valleys is undulating to gently rolling, and, in the main, admirably suited to tillage operations. Some minor ridges and hillocks or knolls are included, which, when not representing a subordinate development of the Appalachian Mountain and Plateau province (sandstones and shales), mark the location of resistant phases of limestone or of those accidental situations where the surface has not been worn down to the prevailing level. Parallel ridges of cherty limestone, together with sandstone and shale ridges and mountains belonging in the province, occur in the southern extension of the Great Limestone Valley, particularly in Tennessee, Georgia, and Alabama. The chert ridges, which often stand several hundred feet above the general level of the valley, represent a subordinate development of the uplands division, the prevailing rocks being identical in character at least with the dominant rocks of the limestone uplands.

The valley floors, ranging from 500 to 3,000 feet below the crest of the bordering Appalachian Mountains, vary considerably in elevation above sea level. The average altitude in Pennsylvaia, Maryland, and northern Virginia ranges from about 500 to 1,000 feet. To the south there is a gradual ascent to about 2,700 feet at the Virginia-Tennessee line, and thence southward a gradual slope to 500 feet or less in central Alabama. Streams have cut secondary valleys and gorges from a few feet to 250 feet or more below the general valley level.

The Central Basin of Tennessee and the Bluegrass region of Kentucky represent erosion basins rather than true valleys. Their low surface level as compared with the surrounding Highland Rim gives them the essential characteristics of a valley—that is, a low, smooth floor bordered by higher land. They differ, however, in lacking the elongated shape of true valleys. The average elevation of the floor of the Central Basin of Tennessee is about 600 feet, or approxmiately 400 feet below the level of the Highland Rim. That of the Bluegrass region is somewhat higher, ranging from 500 to 1,000 feet above sea level.

The basin characteristics of these regions are the result of the relatively rapid weathering of the included rocks which consist prevailingly of the purer limestones. The usual undulating and gently rolling surface configuration has resulted from the uniform weathering of the rocks.

PHYSIOGRAPHY AND GEOLOGY OF THE LIMESTONE UPLANDS.

The limestone uplands are typically developed east of the Mississippi River in the Highland Rim of Tennessee. This country has a generally even upland level of distinct plateau character and an elevation of about 1,000 feet. The limestone uplands division of the province includes large areas of almost flat to undulating or gently rolling topography, although in many places the surface has been badly dissected by the encroachment of streams.

As a physiographic division abutting the Cumberland Plateau on the east, the Highland Rim with its plateau surface features strictly represents a lower plane of the Cumberland Plateau. It has been included in the Limestone Valleys and Uplands province for the reason that its rocks are here dominantly of limestone, whereas those of the Cumberland Plateau proper are principally of sandstone, conglomerate, and shale. The greater elevation of the Highland Rim as compared with the Central Basin is due to the high content of insoluble chert in its included rocks. The presence

of this insoluble material accounts for the slower wearing down of the surface and the consequent development of the plateau topography. The limestone highlands of Kentucky are continuous with the Highland Rim of Tennessee, but in places erosion has reached a more advanced stage, with the result that in Kentucky the plateau features are not generally so well preserved.

The limestone uplands of the Ozark region form a broad plateau including extensive areas of cherty limestone with sandstone, shale, and some chert-free limestone. Roughly, the plateau is a broad, flattish dome, with a maximum elevation of 1,700 feet. From the main drainage divide, which follows approximately a line drawn from the St. Francis Mountains in the east to Springfield, Mo., and thence to Fayetteville, Ark., the surface slopes to the northwest and southeast. Extending northward, the surface relief becomes less pronounced and the plateau gradually sinks through a hilly border region and finally fades out along the Missouri River. Southward the plateau is bordered by the Boston Mountains, which represent the highest portion of the Ozark region, and which are included in the Appalachian Mountain and Plateau province. The surface configuration of the region as a whole is strongly rolling to very hilly. There are many slopes which are too steep for cultivation, although the region embraces a large area of land suitable for agriculture.

DRAINAGE.

The limestone valleys of the Appalachian region are drained for the most part by small streams which flow in a northeast or southwest direction into main streams crossing the valleys. This is particularly true of the northern extension of the limestone valleys division, where streams such as the Shenandoah River in Virginia follow the valley courses and empty into larger streams, like the Potomac, crossing the valleys and mountains in their easterly course to the Atlantic Ocean. The central part of the division, however, is drained principally by the Kanawha, flowing west, the Roanoke and James Rivers flowing east, and the southern portion largely by the Tennessee, Coosa, and Black Warrior Rivers.

The limestone highlands and associated basins of Kentucky and Tennessee are drained by a rather intricate system of winding streams which empty into the Ohio River. The drainage of the Ozark Dome is mostly through winding streams, flowing on the north into the Missouri River and on the east and south into the Mississippi and Arkansas Rivers, respectively. The streams are small with the exception of a few of the more important drainageways, such as the Gasconade of the northern slope and the White River of the southern slope.

CLIMATE.

The climatic conditions prevailing throughout this province vary with the latitude and elevation. The latitudinal variation in temperature is measured by the progressive gradation toward lower normals from central Alabama to New Jersey. On account of difference of elevation between the valley floors and the uplands, there is in places sufficient variation in temperature to affect somewhat the crop adaptation and yields, particularly as influencing the length of the growing season. In general, however, the range of elevation between the two divisions is not wide enough to bring about any material alteration in the type of agriculture. Ordinarily within the same latitude climatic conditions are not sufficiently dissimilar to cause any considerable variation in the general farming in the two divisions. In the production of fruit, however, climatic environment frequently has a very important influence, even within restricted areas. The poor air drainage of narrow, inclosed valleys and depressions makes fruit culture much more hazardous in such areas than on open, higher ground where cool air does not settle. Vegetables may also suffer and occasionally some of the general farm crops, from the unfavorable climatic conditions obtaining in such situations.

SOILS.

The soils of the Limestone Valleys and Uplands province are composed of residual material derived very largely from limestones and dolomitic limestones. Some areas are influenced to varying degrees by materials from sandstones and shales associated with the limestones.

The reduction of the limestones and dolomitic limestones to soil has been accomplished chiefly by the removal of calcium and magnesium carbonates through process of solution, the less soluble components being left to form the soil. In the case of

the purer limestones the present soil mantle represents a very small proportion of the original rock, the larger part having been carried away in solution by gravitational and stream waters. Many feet of rock have thus been required to form a thin layer of soil.

Differences in the character of the parent rocks, especially in content of insoluble material such as chert, have given rise to a number of soil series of widely varying characteristics. The province includes two main soil series, one comprising soils derived from pure or chert-free limestones, as typically represented by the Hagerstown series, and the other comprising soils derived from cherty and siliceous limestones, represented by the Clarkville series. The members of the Hagerstown series are universally more productive than the corresponding Clarksville types, except where affected by poor drainage or refractory structure.

The Shenandoah limestone and its chronological equivalents represent the type of the pure or chert-free limestones, giving rise to the soils of the Hagerstown order, while the St. Louis limestone is typical of the cherty limestones, giving rise to the Clarksville order of soils.

Soils of sandy texture are of limited development in this province, being confined to those areas in which the material derived from both sandstone and limestone, usually interbedded with strata of these rocks, or to situations where limestone material has been covered by or mixed with sand washed from higher portions occupied by sandstone soils.

A large area has been mapped as stony loam. This includes areas in which erosion has kept closer pace with rock weathering than over other soils of the province, others which have been covered by rocks falling from adjacent slopes and ledges, and still others where the stones represent the more resistant portions of the cherty parent rocks.

Of the pure or chert-free limestone soils the Hagerstown, Decatur, Brooke, Colbert, and Conestoga are the most important series. Local areas contain chert derived from strata interbedded with the pure limestone, but the extent of such phases is relatively small within the limits of the Hagerstown series. All of these soils, with the exception of the Brooke series, are confined to the limestone valley division of the province.

The Hagerstown series is found extensively throughout the Appalachian Valley, from eastern Pennsylvania, nearly to central Alabama, and throughout the Central Basin of Tennessee and the Bluegrass Region of Kentucky. The soils are brownish with brown to reddish, moderately stiff clay subsoils. They are well drained, productive, and the surface features are prevailingly favorable to cultivation.

The Decatur soils are most widely developed in the valleys of Alabama, Georgia, and Tennessee. Smaller areas occur throughout the valley division of the province, but the series represents mainly a southern group of soils. These soils also occur to some extent in the uplands division of the province; particularly in the Highland Rim of Tennessee and Kentucky. In places the characteristic deep-red color seems to have been caused by an advanced stage of oxidation, but doubtless the high iron content of the parent rock is responsible for the distinguishing color. These are also strong, well-drained, productive lands having for the most part a surface configuration suited to tillage operations.

The Brooke series includes relatively small, scattered areas occupying hilltops and crests of ridges in the eroded portion of the Appalachian Plateau region of West Virginia, southwestern Pennsylvania, and eastern Ohio. Remnants of limestone strata, originally interstratified with the dominant sandstones and shales of the region, and exposed by erosion, give rise to the Brooke soils. They resemble somewhat the Hagerstown soils in character of material, but are markedly different in topography, color, and in the more plastic structure of the subsoil. The types mapped are all strong soils, although local topography in many places makes cultivation impracticable.

The Colbert series has grayish soils and plastic clay or silty clay subsoils of a mottled yellow and gray color. Where typically developed they occupy flat areas of poor surface drainage. In their natural state they are not very productive, but when artificially drained are capable of supporting good crops, except in cases where the intractable clay subsoil lies near the surface. So far these soils have been mapped only in Georgia and Alabama.

The soils of the Conestoga series are distinguished by the greasy feel of the subsoil. This peculiar feature is due to the presence of mica flakes derived from the parent schistose limestone. These soils are fairly productive, although yields are slightly lower than for the corresponding members of the Hagerstown series. These soils may occur wherever the schistose limestones are developed.

The Hollywood series, which seems to be derived principally from pure limestone, is of limited extent, having been encountered only in the valleys of Alabama and Georgia. The most distinctive feature of the series is the black color of the material.

The Clarksville, Senlon, Guthrie, Baxter, Frankstown, and Locust series represent the cherty and siliceous limestone soils belonging to the Clarksville group. These soils very largely belong in the upland division of the province.

The Clarksville series includes soils, the fine material of which is predominantly of silty texture, gray in the surface portion, and yellowish in the subsoil. The material is derived from cherty and siliceous limestones. Some cherty material is always present, being pronounced in all of the more important types, except the silt loam. The Clarksville soils are inherently less productive than the Hagerstown and other well-drained soils derived from purer limestones.

The Guthrie soils represent light colored, poorly drained material of similar origin as the Clarksville, with which the series is closely associated in occurrence. They are less productive than the corresponding types of the Clarksville series on account of the poorly established drainage.

Soils of the Baxter series have been mapped only in the Ozark Plateau. These soils are very closely related to the Clarksville, both in physical characteristics and origin. The chert content is apparently more calcareous, while the subsoils ordinarily carry a larger percentage of clay. These soils are possibly a little more productive than the Clarksville, owing to the calcareous nature of the chert.

The Senlon series has also been mapped only in the Ozark Plateau. The main characteristics are the heavy silty clay subsoil which passes downward first into lighter textured silt loam and then into a layer containing a large quantity of angular chert fragments. This series is related to the Locust soils of the limestone valley division of the province east of the Mississippi River, the chief difference being the reddish-brown color of the subsoil of the former series.

The Frankstown series of the northern limestone valleys, unlike the other soils of the cherty group, includes large quantities of flinty chert fragments with a considerable amount of soft, partially decomposed yellowish rock. The material is derived from an impure limestone of the Helderberg formation. The Frankstown soils are more productive than most of the corresponding types of the Clarksville series.

The other series of the Limestone Valleys and Uplands province are derived from limestone mixed with sandstone or shale, or both. They are not so extensive as the important Clarksville and Hagerstown series, and, under similar conditions of drainage, are generally less productive.

A considerable proportion of the stony loams can be profitably cultivated, especially where the land is cleared of the more cumbersome stones, while much of that which is too steep or stony for plowing can be used to advantage for pasturage and for the growing of fruit.

AGRICULTURE.

The larger part of the land included in the Limestone Valleys and Uplands province is suitable for agriculture. The soils are inherently productive and admirably adapted to the general farm crops, fruit, and pasturage, making practically the entire area highly valuable farming land. A considerable proportion of the soils of low productivity can be easily built up by a system of careful soil management, including a well-balanced crop rotation in which the legumes and other crops supplying organic matter are given a prominent place. Applications of lime and commercial fertilizers in moderate amounts should be added and growing crops given opportune and thorough cultivation.

In this soil province 9,294,526 acres have been surveyed on a detailed scale of 1 inch to the mile, and 1,093,568 acres on a reconnoissance scale of 4 to 6 miles to the inch, which, with an overlap of 298,432 acres, leaves a net area of 10,089,662 acres surveyed. In 9,710,014 acres soil series have been established, and in 8,911,870 acres of this area the soil type has been determined, leaving 798,144 acres in which the material or series is known, but where the type has not been differentiated. There are 379,648 acres of miscellaneous material which is mainly nonagricultural.

DESCRIPTION OF THE SOIL SERIES.

Athol series.—The soils of the Athol series are brown to reddish brown in color, and the subsoils light brown to reddish brown. They include material having some of the characteristics of both the Penn and Hagerstown series, such areas being locally styled "all sorts land." The soils are derived from limestone conglomerates, including water-worn fragments of limestone and gray and red sandstone. The soils are productive, being well suited to wheat, oats, corn, grass, and clover.

Area and distribution of the soil of the Athol series.

Soil name.	State or area.[1]	Acres.
Athol loam	Pennsylvania 3	3,968

[1] For key to number in this column see p. 773.

Baxter series.—The soils range in color from black through reddish brown to gray or pale yellow, with a stone content varying from rather conspicuous to negligible. The subsoils are yellow, greenish yellow, or brown to dark reddish brown. The layer of soil material above the solid rock is thin. In areas where erosion is active there are large areas of "glades." Both soil and subsoil are derived from a series of pure and argillaceous, moderately cherty limestones, with thin interbedded layers of shale. The two principal varieties of rock are a fine-grained, crystalline, gray, rather heavily bedded limestone or magnesium limestone with chert in beds and nodules, and argillaceous, noncrystalline, soft, white to creamy white limestone and magnesium limestone (cotton rock), with chert mainly in nodules. The main body of the chert occurs in the crystalline rock. The shale layers are blue to greenish yellow, calcareous, and vary from 1 inch to 10 feet in thickness.

These soils differ from the Clarksville in being less stony, usually paler in color, and slightly less productive. The subsoils differ from the Clarksville subsoils in having a stronger color, either greenish yellow or dark reddish brown. They are also less stony than the Clarksville. The stone in the Clarksville occurs as small angular to subangular fragments of amorphous to cryptocrystalline chert, while in the Baxter soils the stone occurs both in large fragments several hundred pounds in weight, of round, cellular, brecciated, and oolitic chert, and also in nodules with concentric banding. The Baxter chert seems to be less calcareous than the Clarksville chert.

Area and distribution of the soil of the Baxter series.

Soil name.	State or area.[1]	Acres.
Baxter silt loam	Missouri 6; Wisconsin 7	27,648

[1] For key to numbers in this column see p. 733.

Brooke series.—The soils are grayish brown to brown, with yellowish-brown to slightly reddish-brown clay subsoils. The series is typically developed on the crests of ridges and hills and in plateau-like situations. The soils are derived from pure limestone with an occasional admixture of material from associated sandstones and shales. The parent rock usually represents the exposed limestone strata of the Monongahela and Dunkard formations, including interbedded sandstones, shales, and limestones, the sandstone and shale having been removed in such a way as to expose the limestone. These soils have good drainage, are easily cultivated, and fairly productive. Wheat, corn, oats, and apples do well.

Area and distribution of the soils of the Brooke series.

Soil name.	State or area.[1]	Acres.
Brooke silt loam	Pennsylvania 18	7,616
clay loam	Pennsylvania 18; West Virginia 4, 6, 7, 8, 10	50,240
undifferentiated	Pennsylvania 16	301,504
Total		359,360

[1] For key to numbers in this column see p. 733.

Clarksville series.—The surface soils are gray and the subsoils yellow and usually silty clay in texture, and frequently underlain by a reddish substratum. The depth to red material varies with the topography, being deeper in the more level areas. The more complete crystallization of the parent limestone has the same effect on the subsoil as the smoothness of the topography. Cherty material is usually present in

varying amounts, considerable areas being very gravelly from the surface downward. These soils occur over both level and undulating uplands and rough, hilly country with steep slopes. In the smoother areas chert and stone are less abundant. These soils in places are derived from cherty limestones. Those areas carrying little chert appear to be derived from limestone which originally carried less chert than that giving rise to the gravelly and stony areas. These soils are typically and extensively developed in northern Alabama, Tennessee, and Kentucky. They are variously adapted to tobacco, grass, small grains, corn, strawberries, cantaloupes, and, under proper climatic conditions, to cotton.

Area and distribution of the soils of the Clarksville series.

Soil name.	State or area.[1]	Acres.
Clarksville gravelly sandy loam	Alabama 6, 35	17,024
fine sandy loam	Alabama 23	1,856
loam	Alabama 6, 10, 35; Tennessee 4	129,024
stony loam	Alabama 3, 4, 6, 8, 10, 15, 16, 21, 23, 35; Arkansas 2; Georgia 18; Missouri 5, 6, 7, 8, 9, 11, 13, 18, 22; Tennessee 1, 2, 3, 5, 7, 9, 10, 12.	3,029,268
gravelly loam	Alabama 15, 20, 28, 37; Georgia 18; Missouri 11	220,096
silt loam	Alabama 19, 23, 26; Arkansas 2; Kentucky 4, 7; Missouri 4, 6, 7, 9, 11, 18, 22; Tennessee 1, 3, 7, 9, 10, 12.	1,733,762
clay loam	Alabama 26; Kentucky 7; Tennessee 9	102,084
Total		5,233,114

[1] For key to numbers in this column see p. 733.

Colbert series.—The surface soil of the Colbert series is grayish to light brown and the subsoil yellow and frequently of plastic structure. The series is derived from pure limestone or limestone mixed with sandstone. The soils are typically developed as flat to undulating valley lands. Both surface and underdrainage are frequently poorly established. With proper drainage, wheat, oats, corn, and forage crops can be grown with good results.

Area and distribution of the soils of the Colbert series.

Soil name.	State or area.[1]	Acres.
Colbert fine sandy loam	Alabama 10	960
silt loam	Alabama 10, 20, 26	51,264
clay loam	Alabama 10	3,136
silty clay loam	Alabama 20, 26, 28; Georgia 18	39,808
clay	Alabama 10	1,408
stony clay	Alabama 20, 28; Georgia 18	10,368
Total		106,944

[1] For key to numbers in this column see p. 733.

Conestoga series.—The soils of this series are yellowish-brown to brown. The subsoils are yellow greenish, occasionally mottled with gray, and have a greasy feel. Occasionally the subsoil assumes a reddish cast. These soils are derived from schistose limestone and calcareous shale or shaly limestone usually containing finely divided mica. Fragments of the parent rock are of common occurrence in the subsoil and throughout the soil section. The soils are not quite as productive as the corresponding members of the associated Hagerstown series, but are suited to the production of general farm crops, such as wheat, oats, corn, clover, and grass.

Area and distribution of the soils of the Conestoga series.

Soil name.	State or area.[1]	Acres.
Conestoga loam	Pennsylvania 9, 12	52,344
clay	Tennessee 5; Virginia 1	64,128
Total		116,472

[1] For key to numbers in this column see p. 733.

Decatur series.—The soils are characteristically a reddish-brown to deep red color and subsoils an intensely red or blood-red color. They are derived mainly from pure limestone, although some areas show traces of chert. These soils are developed as nearly level to gently rolling valley lands. They also occur to some extent in the uplands division of the province. They are admirably adapted to corn, small grains, and forage crops. Under proper climatic conditions cotton can also be grown.

Area and distribution of the soils of the Decatur series.

Soil name.	State or area.[1]	Acres.
Decatur loam	Alabama 3, 4, 6, 20, 28, 35; Georgia 18; Tennessee 10	88,128
stony loam	Alabama 6, 20, 35; Tennessee 10	132,608
cherty loam	Alabama 26	23,040
silt loam	Alabama 10; Missouri 5; Tennessee 3, 12	72,128
stony silt loam	Missouri 5	15,872
clay loam	Alabama 3, 6, 15, 20, 21, 26, 28, 35; Georgia 18; Tennessee 1, 4; Virginia 9.	282,240
silty clay loam	Alabama 26	38,976
clay	Tennessee 4	15,040
Total		668,032

[1] For key to numbers in this column see p. 733.

Duffield series.—The Duffield soils are brown to yellowish-brown and often contain many shale and occasional limestone fragments. The subsoils are yellowish to reddish-yellow, being occasionally darker where derived from dark-blue shales, and usually red to reddish-yellow where the underlying limestone bed is thick. The soils are well drained. They do not suffer from erosion. The soils are derived from alternating shale and limestone beds. The shales are yellowish, reddish, bluish, and greenish. The limestone layers are usually thin, but are occasionally massive.

Area and distribution of the soil of the Duffield series.

Soil name.	State or area.[1]	Acres.
Duffield, undifferentiated	Pennsylvania 15	14,400

[1] For key to number in this column see p. 733.

Fort Payne series.—These soils are gray to light yellow, the subsoils grading quickly from a yellow silty clay loam to a stiff, sticky, impervious clay faintly mottled with red. The movement of moisture is so slow in the impervious subsoils as to make the soils excessively droughty in dry seasons. The soils are derived from shales, argillaceous and shaly limestone, and dolomitic limestones, varying according to the character of the parent rock. The clay and clay loam are derived from shales and argillaceous or shaly limestone, while the loam and stony loam are mainly derived from Knox dolomite. The topography varies from gently rolling to high and hilly. These soils do not form desirable agricultural land. Corn and wheat give only moderate yields.

Area and distribution of the soil of the Fort Payne series.

Soil name.	State or area.[1]	Acres.
Fort Payne clay loam	Tennessee 5	9,536

[1] For key to number in this column see p. 733.

Frankstown series.—The soils of the Frankstown series are grayish to light brown in color, and the subsoils pale yellow and friable. Small fragments of a soft, yellowish, partly weathered rock and fragments of a hard grayish to pinkish flinty rock occur on the surface and throughout the soil section. In many places the substratum contains 50 per cent or more of this soft yellowish rock. These soils are typically developed on the smooth but rather narrow ridges of the Appalachian Mountain

regions of Pennsylvania and possibly over similar regions to the south. They usually occupy situations considerably higher than the Hagerstown soils and are locally known as "gravelly land," "bastard limestone," and "limestone land." The material is derived from the shales and cherty limestones of the upper part of the lower Helderberg formation. Occasionally limestone is encountered in the series, but generally it is not seen in sections of any considerable depth. These soils are quite productive, being suited to wheat, corn, clover, and grass, and to certain varieties of apples, particularly the Jonathan.

Area and distribution of the soil of the Frankstown series.

Soil name.	State or area.[1]	Acres.
Frankstown stony loam	Pennsylvania 2, 8	31,168

[1] For key to numbers in this column see p. 733.

Guthrie series.—This series includes the grayish to almost white silty soils developed in flat or slightly depressed areas having poor surface drainage. The subsoils are usually pale yellow or pale yellow mottled with gray, and are rather compact in structure. They are associated with the Clarksville soils and really represent poorly drained areas of the latter series. Under ordinary conditions they are best suited to grasses, but when drained can be used for corn and other grain crops with fairly satisfactory results.

Area and distribution of the soils of the Guthrie series.

Soil name.	State or area.[1]	Acres.
Guthrie silt loam	Alabama 10, 35; Kentucky 4; Missouri 5; Tennessee 1, 3, 10, 12.	9,216
clay	Alabama 19, 23; Kentucky 2; Tennessee 9	20,584
Total		29,800

[1] For key to numbers in this column see p. 733.

Hagerstown series.—The soils of the Hagerstown series are prevailingly brown in color, with light-brown to reddish-brown subsoils. In some areas the subsoil is red or dull red, but never so pronounced in color as that of the Decatur series. These soils are most typically developed in the limestone valleys of the Appalachian Mountain region and in the central basins of Kentucky and Tennessee with outlying areas in the adjoining Piedmont Plateau region. Fragments of limestone and outcrops are of common occurrence. The topography is undulating to gently rolling, well suited to cultivation. The soils are very productive and admirably adapted to corn, small grain, clover, bluegrass, timothy, apples, and in the Southern States to cotton.

Area and distribution of the soils of the Hagerstown series.

Soil name.	State or area.[1]	Acres.
Hagerstown sandy loam	Alabama 19; Pennsylvania 2, 8; Tennessee 11; Virginia 1, 3, 7; West Virginia 3.	66,502
fine sandy loam	Alabama 26	6,720
loam	Alabama 15, 16, 19, 20, 21, 23, 26, 28; Kentucky 2, 3, 5; Pennsylvania 1, 2, 3, 5, 6, 9, 10, 12; Tennessee 2, 3, 5, 7, 11; Virginia 1, 3, 7, 9.	1,192,646
stony loam	Alabama 19, 20, 21; Pennsylvania 1, 2, 3, 5, 8, 11; Tennessee 1, 3, 4, 10, 11, 12; Virginia 1, 3, 9.	382,702
silt loam	Georgia 18; Kentucky 4; Missouri 4; Pennsylvania 2, 5, 8; Tennessee 1, 12; Virginia 9.	317,632
clay loam	Alabama 20, 28; Pennsylvania 2, 3, 5, 8, 9; Virginia 9	139,784
clay	Alabama 16, 19; Georgia 18; Kentucky 2, 3, 5; Pennsylvania 5, 9; Tennessee 5; Virginia 1, 3; West Virginia 3.	363,546
stony clay	Alabama 4, 15; Kentucky 2; Tennessee 4	55,808
undifferentiated	Pennsylvania 13, 15	475,648
Total		3,000,988

[1] For key to numbers in this column see p. 733.

Hollywood series.—The soils of this series are characterized by their dark-gray to black color, heavy texture, and refractory structure. The subsoils consist of dark-gray to yellow, sticky, heavy clay, occasionally mottled with red. The soils are of limestone origin and occupy low, flat limestone valleys, being frequently found near streams. The prevailing refractory structure of the soil makes cultivation difficult except under favorable conditions of moisture. Corn and grass are the principal crops, giving fair yields.

Area and distribution of the soils of the Hollywood series.

Soil name.	State or area.[1]	Acres.
Hollywood clay loam	Alabama 26	1,920
clay	Alabama 20	1,088
Total		3,008

[1] For key to numbers in this column see p. 733.

Locust series.—These soils are grayish yellow, the subsoils consisting of a yellow silty clay underlain by a stratum of gravel. They are found as strips near drainage-ways. The surface is slightly undulating and drainage good. The soils are productive, giving good yields of cotton and corn.

Area and distribution of the soil of the Locust series.

Soil name.	State or area.[1]	Acres.
Locust silt loam	Alabama 15	4,992

[1] For key to number in this column see p. 733.

Murrill series.—The soils of the Murrill series are brown, with yellowish-brown to reddish subsoils. They occupy undulating to gently sloping areas, near the foot of mountains and ridges and are derived from sandstone, shale, and limestone material. The subsoil usually consists of residual material from limestone, modified somewhat by shale in certain areas. The surface soils consist principally of colluvial material from the adjoining slopes and are composed chiefly of sandstone and shale, though some limestone enters into this colluvial wash. The members are less productive than the well-drained associated limestone soils, but are well suited to corn, wheat, oats, grass, and clover. The sandy members produce good yield of vegetables.

Area and distribution of the soils of the Murrill series.

Soil name.	State or area.[1]	Acres.
Murrill silt loam	Pennsylvania 2	8,704
clay loam	Virginia 3	15,720
undifferentiated	Pennsylvania 15	6,592
Total		31,016

[1] For key to numbers in this column see p. 733.

Pennington series.—This series includes light-brown soils with mottled yellow and blue, intractable subsoils. The members are found along the lower slopes where seepage waters from higher soils keep the material in a soggy condition throughout a good part of the year. Owing to their position more or less colluvial material has been deposited over the surface. The soils are derived from interbedded, calcareous shales and impure limestones. In their present condition they have little agricultural value, but when well drained they should become productive.

Area and distribution of the soil of the Pennington series.

Soil name.	State or area.[1]	Acres.
Pennington clay	Kentucky 4	256

[1] For key to number in this column see p. 733.

Pocahontas series.—The Pocahontas soils are yellowish gray to light brown and prevailingly of silty texture and friable structure. The subsoils consist of yellowish silty clay loam to silty clay. These soils, while frequently associated with the Clarksville, are of superior productivity. The brownish color is more pronounced, the topography smoother, and the soils chert free. The materials are derived from shales with some included limestones. The surface configuration is well suited to agriculture, and the types are considered excellent agricultural soils, being adapted to corn, clover, wheat, cowpeas, grass, and, under proper management, to alfalfa.

Area and distribution of the soil of the Pocahontas series.

Soil name.	State or area.[1]	Acres.
Pocahontas silt loam	Missouri 4	23,616

[1] For key to number in this column see p. 733.

Senlon series.—The soils of the Senlon series have a brown color and friable structure. The subsoils are brown to reddish brown and contain large amounts of angular chert gravel in the lower portion. These soils are characteristically developed in strips along streams having a gentle slope from the first bottom land back to the foot or base of the uplands proper. The material is mainly colluvial in origin, having been washed down from upland residual soils derived principally from cherty limestone. These are good agricultural soils and well suited to corn, oats, and grass.

Area and distribution of the soil of the Senlon series.

Soil name.	State or area.[1]	Acres.
Senlon silt loam	Missouri 11	6,528

[1] For key to number in this column see p. 733.

Tilsit series.—These soils range from pale yellow or light brownish yellow to gray, with brownish-yellow subsoils. The soil in the lower portion has a faint reddish tinge with mottlings of yellow, gray, and brown. The material is derived from fine-grained sandstones modified to some extent by material derived from the overlying limestone beds. In some cases the sandstones are interbedded with the limestones of the Limestone Valleys and Uplands province. The soils differ from the Dekalb series in their relatively smooth topography, their more intimate association with limestone soils, and in their brownish-yellow color. The topography of the areas in which they occur is undulating to hilly, but not mountainous.

Area and distribution of the soil of the Tilsit series.

Soil name.	State or area.[1]	Acres.
Tilsit silt loam	Missouri 4	39,168

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SANDY LOAM GROUP.

The sandy loam group is represented in the Limestone Valleys and Uplands province, so far as the soil surveys have extended, by one type, the Hagerstown sandy loam. This has been encountered in various portions of the valley, from Pennsylvania to Alabama, although the area mapped is rather small. The sandy material is generally derived from sandstone rocks associated with the limestones, giving rise to the typical Hagerstown material.

The sand content gives the soil a friable structure, making it considerably easier to cultivate than the heavier soils of the province. The subsoil, which usually is encountered within 10 to 15 inches of the surface, is a rather compact clay and retentive of moisture. These soils, therefore, have good drainage in the surface portion, but are not excessively drained as are some of the sandier types of the Atlantic and Gulf Coastal Plains.

Crops usually reach maturity on these light-textured soils somewhat earlier than on the heavier types, making them better suited to the production of early vegetables than any of the other soils of the province.

The general farm crops give moderate to good yields where properly managed, especially where a good organic content is maintained. Grass does not do as well as on the heavier soils. Peaches and certain varieties of apples do well.

Hagerstown sandy loam.—The soil consists of a gray to yellowish or light-brown sandy loam about 12 inches deep. The subsoil is a yellowish-red clay, grading into a stiff red clay in the lower portion. The type occupies some of the higher ridges of the valley and is well drained. The soil material is chiefly of residual origin, being derived from limestone and modified to some extent by sandy material from either sandstone, arenaceous limestone associated with the purer limestone, or from colluvial material derived from adjacent slopes.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Hagerstown sandy loam......	Alabama 19; Pennsylvania 2, 8; Tennessee 11; Virginia 1, 3, 7; West Virginia 3.	66,502

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The Clarksville gravelly sandy loam is the only member of this group so far encountered. This type occupies hilly to rolling areas, generally near streams. Its sandy character is due to the influence of either arenaceous limestone or sandstone. It is not likely that any considerable area of land represented by members of this group will be found within the Limestone province. Where encountered they probably will be of low agricultural value because of their unfavorable surface features and a high gravel content which renders cultivation difficult.

Clarksville gravelly sandy loam.—The soil to a depth of 6 to 12 inches consists of a gray to grayish-brown, silty fine sandy loam or silty sandy loam, carrying a moderate to high percentage of small fragments of chert mixed with shale and sandstone, and, in places, rounded sandstone. The subsoil is a grayish to yellow heavy loam or silty clay loam which frequently grades into a reddish or yellow silty clay. The type is of residual origin, and usually occupies the smoother, lower slopes which in places have been influenced by colluvial material. The soil is well drained. Under ordinary methods of farming only fair yields of the general farm crops, principally corn and cotton, are secured. The type is well suited to Irish and sweet potatoes, cantaloupes, and strawberries. Apples, plums, pears, raspberries, and blackberries do well.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Clarksville gravelly sandy loam	Alabama 6, 35	17,024

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loam covers a very small area in this province, being represented by patchy occurrences where several important series have been influenced by material from fine-grained sandstone and arenaceous limestone. These soils give fairly good results with medium-early vegetables. The general farm crops yield well where the soil is carefully handled, its productiveness being nearly equal to that of the loam group. The land is easily plowed and kept in a good state of tilth. The areas usually are not sufficiently extensive to warrant the establishment of very important trucking industries.

Clarksville fine sandy loam.—The soil, varying in depth from 6 to 15 inches, is a gray fine sandy loam of loose texture. The subsoil, to a depth of more than 3 feet, is a red sandy clay, the sand content being more pronounced in the upper portion, or a yellow silt loam to silty clay loam sometimes grading into a reddish clay loam or clay. The surface features are not uniform, varying from low rolling hills to narrow ridges. The type has been formed largely from remnants of the sandy layers of the Lafayette formation, mixed with the clays of the underlying limestone. Surface drainage is complete, but the subsoil is capable of retaining a large quantity of moisture. The soil should be excellent for peaches, and, where well drained, for cotton and other general farm crops.

Colbert fine sandy loam.—The soil is a gray to brownish fine sandy loam 6 to 8 inches deep, underlain by yellow or mottled gray and yellow, heavy, fine sandy loam or sandy clay. The topography is gently rolling to slightly undulating. In agricultural value the type lies between the red limestone land and the gray mountain lands of the Coal Measures.

Hagerstown fine sandy loam.—The type consists of a light-brown to reddish-brown fine sandy loam, from 6 to 12 inches deep, underlain by a red or reddish-brown, somewhat friable, fine sandy clay. The fine material is derived mainly from limestone, the coarser particles of sand coming principally from the associated sandstones. The soil is adapted to the general farm crops of the region. Some of the vegetables can also be grown.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Hagerstown fine sandy loam	Alabama 26	6,720
Clarksville fine sandy loam	Alabama 23	1,856
Colbert fine sandy loam	Alabama 10	960
Total		9,536

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loam group includes a very large portion of the Limestone Valleys and Uplands province, ranking next to the silt loam types in extent. The group is represented throughout that portion of the province east of the Mississippi River. The texture of these soils is largely influenced by the character of the rocks from which they are formed.

When properly plowed and harrowed these soils assume a mellow structure which is easily maintained, especially where rotations are practiced which include an occasional organic-matter supplying crop, such as cowpeas and clover. Good implements and fairly heavy stock are necessary to handle the loam soils properly. The topography in most cases permits of ready cultivation without danger of destructive erosion.

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All the members of the group are ideal general farm crop soils. Some of them are naturally more productive than others, but the inferior lands can be built up, particularly with applications of lime, deep fall plowing, and crop rotations which include the legumes. Wheat, corn, oats, rye, tobacco, cowpeas, clover, and vetch give good results on a large part of the loams. Grass also does well on certain types, particularly the Hagerstown loam, both as a hog crop and for grazing. A number of vegetables, such as Irish potatoes, cabbage, and spinach do well as medium and late crops. Apples and peaches give good returns in those situations having proper air drainage. Cotton can be grown in the more southerly areas.

The Hagerstown loam is by far the most extensive of the group. Over a million acres have been mapped in various portions of the Limestone Valleys from Pennsylvania to Alabama, the Central Basin of Tennessee, and the Bluegrass Region of Kentucky. This is naturally a fertile soil and is easily cultivated and maintained in a high state of productivity.

The Clarksville type is found on rather small tracts in those valley areas occupied by cherty limestones throughout the Highland Rim of Alabama, Tennessee, and Kentucky. It is considerably less productive than the Hagerstown loam, but gives fair to good returns, according to treatment.

The Decatur loam, which occupies some fair-sized areas in the Limestone Valleys, particularly in Alabama, Georgia, and Tennessee, is equal in productivity to the Hagerstown loam, and is somewhat more durable.

The Conestoga loam is distinguished from the other types of the group by the greasy feel of the subsoil. It is not so productive as the Hagerstown and Decatur loams. The type has a moderate development in the northern section of the province.

The Athol loam is local in occurrence. It owes its somewhat irregular characteristics to the variable nature of the parent rock, consisting mainly of limestone conglomerate.

Athol loam.—The surface soil consists of a brownish-red to light-brown medium loam to heavy silty loam about 10 inches deep. The subsoil is reddish-brown, yellowish-red, or yellow clay loam or sandy clay. The soil is similar in some respects to both the Hagerstown silt loam and Penn loam, but is recognized as a distinct type. It is derived from a breccia known as Potomac marble, composed of water-worn fragments of limestone, Cambrian sandstone, and Triassic sandstone embedded in a matrix of Triassic material. Rock outcrops occur in places. The surface is gently to moderately rolling. The type is adapted to general farming. Wheat yields from 12 to 28 bushels, corn 30 to 50 bushels, oats about 38 bushels, and timothy 1 to $1\frac{1}{2}$ tons per acre.

Clarksville loam.—The soil is a light-brown, yellow or gray silty loam to silty fine sandy loam, 8 inches in depth carrying a few cherty and siliceous limestone fragments. The subsoil is a heavy, yellow silt loam grading frequently into a reddish-yellow silty clay loam, becoming a dark-red silty clay loam or clay at a depth of 36 inches. The type occupies rolling to hilly areas and is inclined to be droughty. It is derived from siliceous limestone or dolomite. It produces fair crops of cotton. Strawberries and cantaloupes do well, while corn gives moderate yields.

Conestoga loam.—The type consists of a brown loam about 12 inches deep, underlain by a light clay loam, grading at a depth of 30 inches into partially decomposed schistose limestone. It occupies rolling valley land and is derived from the decomposition of schistose limestone. It has a greasy or soapy feel when rubbed between the fingers. It is recognized as an excellent soil for general agriculture.

Decatur loam.—This type consists of a brown heavy fine sandy loam to dark-brown friable loam from 4 to 10 inches deep. The subsoil is a bright-red or yellowish-red clay grading into a stiff, sticky, dark-red clay. Occasional gravel areas occur near stream courses. The type occupies rolling uplands in the vicinity of the larger streams. Drainage is good and the type suffers but little from erosion. The material is largely of residual origin from limestone rocks, influenced somewhat by colluvial or residual material from associated siliceous limestone and sandstone. The type is adapted to cotton, small grain, corn, grass, small fruits, and tree fruits. Alfalfa can be made a successful crop.

Hagerstown loam.—The soil is a brown or yellow loam, averaging about 12 inches in depth. The subsoil is a yellow or reddish clay loam to a depth of 24 inches, but frequently grades into a stiff, yellowish-red clay. The type occupies rolling valley land, and is derived from the weathering of pure limestone. This is a typical corn soil. It is one of the best general farming types in the Eastern States and is used for corn, tobacco, wheat, grass, and apples.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Hagerstown loam	Alabama 15, 16, 19, 20, 21, 23, 26, 28; Kentucky 2, 3, 5; Pennsylvania 1, 2, 3, 5, 6, 9, 10, 12; Tennessee 2, 3, 5, 7, 11; Virginia 1, 3, 7, 9.	1,192,646
Clarksville loam	Alabama 6, 10, 35; Tennessee 4	129,024
Decatur loam	Alabama 3, 4, 6, 20, 28, 35; Georgia 18; Tennessee 10	88,128
Conestoga loam	Pennsylvania 9, 12	52,344
Athol loam	Pennsylvania 3	3,968
Total		1,466,110

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony loams, according to the soil surveys already made, embrace a larger area than any other group or phase group of soils encountered within the Limestone Valleys and Uplands province. The material is practically identical with that of the corresponding loam types, the important difference being the prevailingly rougher topography and greater quantity of stone fragments present. The members of this phase group have about the same crop adaptation as the corresponding members of the loam group, but the yields average considerably lower, on account of the difficulty encountered in their cultivation.

Over 3,000,000 acres of the Clarksville stony loam have been mapped in the Highand Rim region of Alabama, Kentucky, and Tennessee, in the cherty ridges of the limestone valleys of Tennessee, Georgia, and Alabama, and in the Ozark Plateau. The type occupies the most deeply dissected, steepest, and roughest portions of these regions. It is derived from cherty limestone and is thickly strewn with small and large stones of cherty material. A considerable part of the type is best suited to pasturage, forestry, apples, and peaches.

The Hagerstown stony loam has an extensive development in the limestone valleys from Pennsylvania to Alabama, and in the basins of Tennessee and Kentucky. Where not too rough and stony it is a productive soil. The stones consist of both limestone and cherty limestone fragments with some sandstone from adjacent slopes. Its crop adaptation is about the same as that of the Hagerstown loam.

The Decatur stony loam is found extensively in the valley regions of Alabama, Tennessee, and Georgia, and ranks approximately as the equivalent of the Hagerstown stony loam. It is derived from cherty limestone and magnesium limestone, the rock fragments consisting mainly of cherty material.

Clarksville stony loam.—The surface soil consists of a gray to light-yellow or brown, silty loam, about 6 inches deep, overlying yellowish-red to red silty clay or clay. Both soil and subsoil contain from 20 to 50 per cent of angular fragments of chert and siliceous limestone. The type occupies rough, broken country with deeply cut, narrow valleys. It is a residual soil, derived from cherty siliceous limestones, and is thin and stony and of little agricultural value. It is largely covered with a thick second growth of oak. It is best adapted to apples and peaches.

Decatur stony loam.—The type consists of a dark-brown silty loam from 6 to 10 inches deep, underlain by a dark-red or yellowish-red, heavy clay loam grading into a stiff, plastic dark-red clay. From 10 to 70 per cent or more of the surface soil is made up of subangular, angular, and rounded sandstone, quartz, quartzite gravel, and stones. Some chert and siliceous limestone occur locally with veins and strata of the same material in the subsoil. The type occupies the lower slopes of mountains and tops and slopes of valley ridges. The surface is rather hilly and rough, which insures good drainage. Droughts are seldom injurious. The type consists largely of residual material from the Knox dolomite which forms the subsoil, while the soil appears to contain much colluvial material. The rounded stones and gravel occurring in some localities have probably been worn by the action of streams rushing down the slopes.

Frankstown stony loam.—The soil is a gray to grayish-brown silt loam underlain at a depth of 6 to 8 inches by a yellowish silt loam. Soft, yellowish, partly-weathered rock fragments are abundant on the surface and throughout the soil section, ranging in size from gravel to large stones. In places they are sufficiently numerous to interfere seriously with cultivation. The soil is derived from the upper portion of the Lower Helderberg formation. The type is locally styled "limestone gravelly land,"

and occupies rather narrow ridges. The soil is productive and gives good results with wheat, corn, clover, grass, and apples.

Hagerstown stony loam.—The soil consists of a silty or fine sandy loam about 8 inches deep, usually brown in color, but varying from light gray to yellowish. The subsoil consists of a yellow or yellowish-red clay loam grading at an average depth of 24 inches into a stiff red clay which extends to unknown depths. Angular fragments of chert and limestone are found on the surface, throughout the soil, and continuing through the first few inches of the subsoil. The type is residual in origin, and derived from the solution of impure limestone containing cherty layers, the insoluble materials being concentrated on the surface. It occupies high ridges and slopes in the limestone valleys. The natural drainage is thorough, but the close-textured subsoil makes the type retentive of moisture and fertilizers. The soil is particularly adapted to fruit growing. Of the field crops corn produces best. Grass also does well.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Clarksville stony loam	Alabama 3, 4, 6, 8, 10, 15, 16, 21, 23, 35; Arkansas 2; Georgia 18; Missouri 5, 6, 7, 8, 9, 11, 13, 18, 22; Tennessee, 1, 2, 3, 5, 7, 9, 10, 12.	3,029,268
Hagerstown stony loam	Alabama 19, 20, 21; Pennsylvania 1, 2, 3, 5, 8, 11; Tennessee 1, 3, 4, 10, 12; Virginia, 1, 3, 9.	382,702
Decatur stony loam	Alabama 6, 20, 35; Tennessee 10	132,608
Frankstown stony loam	Pennsylvania 2, 8	31,168
Total		3,575,746

[1] For key to numbers in this column, see p. 733.

CHERTY LOAM PHASE.

The cherty loam soils are represented in this province in so far as surveyed by only one type, the Decatur cherty loam. The fine material of this type is essentially the same as that of the Decatur loam, but enough chert material is present to make the soil somewhat more difficult to cultivate. The type ordinarily occupies rougher areas than the loam, and varies but little in crop adaptation, although yields average slightly lower owing to rougher topography and increased stone content.

Decatur cherty loam.—The surface soil consists of a reddish-brown to dark reddish-brown loam to silt loam, from 8 to 12 inches deep. The subsoil is a reddish-brown to red clay, the red coloring becoming more pronounced with depth. Fragments and nodules of chert are present on the surface and throughout the soil section in quantities sufficient to interfere with cultivation. The material is derived from cherty limestone. The type occupies slopes and knolls over which erosion has been fairly active, although the presence of chert lessens the damage from this source to some extent. Much of the type is timbered with oak, hickory, cedar, poplar, and some walnut. Cotton, corn, and clover are the crops generally grown with fair to moderately good yields.

Area and distribution of the cherty loam.

Soil name.	State or area.[1]	Acres.
Decatur cherty loam	Alabama 26	23,040

[1] For key to number in this column, see p. 733.

GRAVELLY LOAM PHASE.

Only one type of the gravelly loam soils has been mapped, the Clarksville gravelly loam. It occupies extensive areas in Tennessee, Georgia, and Alabama, where it is confined mainly to those locations occupied by cherty limestone rocks. Most of the type occurs in the cherty ridges of the valley region. The fine material is not very different from that of the Clarksville loam, but the abundance of small, angular chert fragments imparts to the soil the characteristics of a gravelly loam. Most of it is rather difficult to work, especially where the organic matter content has become

depleted. Strong teams and plows are necessary to turn the soil to proper depth, particularly in fields where a low organic matter content has favored the development of conditions approaching a hardpan. Most of the type can be cultivated without danger of serious erosion, since the gravel present tends to hold the soil in place against the force of running water.

Clarksville gravelly loam.—The surface soil consists of a gray to yellowish-gray silt loam carrying a relatively small quantity of fine and medium grades of sand. The subsoil is a grayish to reddish-yellow, heavy silt loam, which quickly grades into a silty clay. From 10 to 25 per cent of small angular chert gravel is found on the surface and smaller quantities appear throughout the soil mass. The type is derived from Knox dolomite. The surface is undulating to gently rolling and cultivation is easy. Fair yields of corn and cotton are obtained. The type is best suited to general farming and stock raising. Cantaloupes and strawberries give fair to good yields.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Clarksville gravelly loam......	Alabama 15, 20, 28, 37; Georgia 18; Missouri 11................	220,096

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loams comprise an extensive area in the Limestone Valleys and Uplands province. They are widely developed over the entire portion of the province east of the Mississippi River, and in the West in the Ozark Plateau division. The texture of the soil is due to the fine-grained character of the parent limestone.

Owing to the tendency of these fine textured soils to assume a compact structural condition after heavy rains, intensive methods of culture with fairly strong tools and heavy teams are required to maintain a good condition of tilth, especially where the supply of organic matter has been allowed to run low. Moderate to liberal additions of lime and organic matter greatly improve the physical condition of these soils.

The members of the silt loam group are adapted primarily to the production of the general farm crops, including corn, wheat, oats, rye, grass for hay and pasturage, tobacco, cowpeas, and clover. Cotton does well in the southern areas. Strawberries, cantaloupes, cabbage, and Irish potatoes do very well on these soils, although they usually mature later than on the lighter textured soils. Apples and peaches give good results in certain localities, particularly on the Hagerstown and Decatur types.

The Clarksville silt loam is the most extensive member of the group, over 1,500,000 acres having been mapped in the Highland Rim and plateau regions of Alabama, Tennessee, Kentucky, and Missouri. East of the Mississippi River it is the dominant soil of the upland division of the province. The surface configuration of the greater part of the type is well suited to tillage operations. The productivity of the soil, however, averages considerably lower than that of the types derived from limestone carrying less siliceous material, such as the Hagerstown and Decatur soils.

The Guthrie silt loam occupies poorly drained depressions within areas of the Clarksville silt loam, the material having been derived from the same rocks as the Clarksville. The gray to white color of the Guthrie is due to poor drainage.

The Hagerstown silt loam has a moderately extensive occurrence throughout the limestone valleys and in the basin regions of Tennessee and Kentucky. This is a very productive soil, adapted to a wide range of general farm crops. Apples also are successfully grown.

The Decatur silt loam is confined mainly to the more southern valleys. This type has about the same capabilities as the Hagerstown silt loam, the important difference being its dark-red color, as distinguished from the brown to reddish-brown color of the Hagerstown soil.

The Colbert silt loam represents a rather poorly drained, flat valley soil, derived principally from pure limestone.

The Baxter silt loam of the Ozark region is rather closely related to the Clarksville, the chief difference being in the more calcareous nature of the included chert and in the higher clay content of the subsoil.

The Brooke silt loam is developed on the high hilltops and ridge crests of the excessively eroded portions of the Appalachian Plateau in West Virginia and southwestern Pennsylvania. This type is derived from remnants of limestone exposed by processes of weathering and erosion, which have removed the overlying beds of sandstone and

shale. The type is a strong general farm crop soil, but it is more difficult to cultivate than the Hagerstown silt loam, on account of its unfavorable topographic position and frequent proximity of the intractable clay subsoil to the surface.

The Tilsit silt loam includes material derived from both limestone and fine-grained sandstone. It is typically developed in the Ozark Plateau region of Missouri. The general farm crops give fair to good returns, according to management.

The Senlon silt loam is another Ozark Plateau type. The subsoil is a heavy silty clay loam, which grades through lighter textured silt loam into a substratum carrying large amounts of angular gravel. It is developed in relatively narrow strips along the slopes of drainage courses. The material is derived largely from cherty limestone. It is a good soil for general farm crops, although not quite so productive as the Hagerstown and Decatur members of the group.

Baxter silt loam.—This soil is a gray, pale yellowish or reddish-brown silt loam ranging from moderately stony to stone free, the stone content consisting of chert in nodules, irregularly shaped fragments, and slabs. The chert varies in structure from banded amorphous and oolitic to cellular. The fragments vary from the size of small gravel to masses weighing a ton. In places, as in Cooper County, Mo., the large bowlders are absent. The subsoil is a yellowish-brown to dark reddish brown clay to silty clay, usually not so stony as the soil, but with a stone content similar to that occurring in the soil. The soil mantle is relatively thin, and rock outcrops frequent. The soil is derived from a series of limestone and magnesian limestones, with occasional thin beds of bluish, grayish, or yellowish calcareous shales.

The limestones and magnesian limestones occur in two phases. One is a dark-gray, fine-grained crystalline rock, containing beds, nodules, and lenses of chert. The other is a gray, cream to white, soft, amorphous, earthy limestone locally called "cotton rock." The subsoil of this type differs from the Clarksville in being less stony, of a darker reddish brown, and in having a higher percentage of clay. The layer of soil material is thinner than that of the Clarksville silt loam.

Brooke silt loam.—The surface soil is a light-brown mellow silt loam, from 8 to 10 inches deep. The subsoil consists of a heavy, tenacious clay ranging in color from light-brown to slightly reddish brown and occasionally mottled, with gray in the lower portion. The type occupies plateau areas and the tops of hills and ridges. It is a very productive soil and is largely under cultivation. Corn yields from 60 to 100 bushels per acre, oats 30 to 60 bushels, wheat 18 to 30 bushels, and hay from 1½ to 3½ tons. Bluegrass, timothy, and clover give good results.

Clarksville silt loam.—The type consists of a light-gray silt loam, averaging about 8 inches deep, underlain by a yellowish, compact silt loam, grading to silty clay with depth. The color of the lower subsoil often changes to reddish yellow or red. The type is of residual origin, derived from siliceous limestones. The topography is flat to gently rolling. The larger and nearly level areas are generally poorly drained. The type is known locally as "barrens" or "flatwoods," and is largely forested with oaks. It is droughty and not considered a strong soil, but with good treatment fair yields of the staple crops can be secured. In Tennessee and Kentucky this soil produces an excellent grade of export tobacco. Special crops, such as strawberries, cantaloupes, and some vegetables, are grown successfully.

Colbert silt loam.—This type consists of a gray loam about 8 inches deep, underlain by a heavier, more compact subsoil, varying in color from yellow or grayish yellow to reddish yellow or mottled yellow and gray color. Limestone fragments in small quantities occur in both soil and subsoil. The type occupies flat or nearly flat valley lands, which frequently have poor surface drainage. It is derived largely from the weathering of pure limestone, modified in some instances by sandstone. The crop value is superior to that of the surrounding Dekalb soils.

Decatur silt loam.—The soil consists of a red or reddish-brown silty loam 6 to 12 inches deep. The subsoil is a reddish-brown or red silt loam, grading into a deep red silty clay. The type is usually free from stone, except for some chert, which is occasionally found in the soil and subsoil. The surface is level to gently undulating, with occasional sink holes. The material is of residual origin from limestone rocks. The type originally supported forests of oak, black and sweet gum, chestnut, and poplar. Corn, wheat, and cotton are the principal crops. Cantaloupes do well.

Guthrie silt loam.—The type consists of 8 to 12 inches of gray or drab compact silt loam, underlain by a compact drab to yellow silt loam. It occupies depressions or sinks in the areas of Clarksville soil. It is composed of residual material and soil washed in from surrounding slopes. Drainage is poorly established and the type locally known as "crawfish land."

Hagerstown silt loam.—The soil is a grayish brown to brown mellow silt loam, with a small content of fine-textured sand and in places some fragments of limestone or shaly limestone. The subsoil is a yellowish-brown to reddish-brown clay loam,

passing, at about 24 inches, into a stiff, heavy, yellowish-red clay, which extends to a depth of 3 feet or more. The subsoil may contain some disintegrated rock fragments. The topography is more or less rolling, insuring excellent drainage. The material is derived from the weathering of the purer grades of limestone, such as the Shenandoah or Valley limestone of Cambro-Ordovician age. It is an excellent general farming soil, producing good crops of corn, wheat, and hay. Fruits and vegetables are also successfully grown. Commercial fertilizers are used to advantage.

Locust silt loam.—The surface soil consists of a grayish yellow silt loam about 14 inches deep. The subsoil is a yellow silty clay, which, at a depth of 5 to 7 feet, often grades into a stratified layer of angular chert gravel. The surface is slightly undulating and slopes toward the streams which traverse it. The type is apparently of alluvial origin, although this point is not fully established. It is well suited to the production of cotton, corn, and hay. Stock raising could be made a profitable industry.

Murrill silt loam.—This soil consists of a grayish brown to brown silt loam, grading at about 15 inches into reddish-yellow silt loam. The subsoil is a silty clay loam to clay loam. Fragments of sandstone are scattered over the surface and disseminated throughout the soil and subsoil. The type occupies the gentler slopes approaching mountains. Along the foot of the slopes it is usually associated with the Dekalb and on the lower side with the Hagerstown soils. Drainage is well established. The soil material is derived from sandstone, shale, and limestone, much of the surface portion having been brought into its present position by colluvial action. Corn, wheat, oats, buckwheat, potatoes, alfalfa, and grass give good results. Apples, peaches, and pears are successfully grown.

Pocahontas silt loam.—The soil to a depth of 9 to 12 inches is a yellowish-gray to light-brown silt loam of friable structure. The subsoil is a yellowish silty clay or silty clay loam. The type is derived from shales, with included limestone. The topography favors agriculture, and good yields of wheat, corn, cowpeas, grass, and clover are secured. With proper management alfalfa would probably do well.

Senlon silt loam.—This type consists of a brown, friable silt loam, having in places a faint reddish cast, and underlain by a brown to faintly reddish-brown heavy silt loam to silty clay loam, which in turn rests upon a brown or reddish-brown friable heavy silty clay. The reddish color becomes more pronounced with increase in depth. In the higher situations the soil is much lighter in color than at lower levels, where it approaches a dark chocolate brown. Little or no gravel is found on the surface, except near the boundaries of the higher gravelly soils. At a depth of 18 to 28 inches angular gravel is abundant. The depth to gravel varies with position, being less in the higher elevations. This type is developed in comparatively narrow strips along drainage courses. For the most part it slopes in the direction of the stream courses with a gradual fall from the base of the ridges forming the outer margin. Drainage is ample, with good underdrainage through the gravel stratum. The soil material is derived from a cherty limestone, but it has been carried down from the original point of derivation by surface waters and by creep and deposited on the slopes. Some chert free limestone material also enters into the composition of the soil. A part of the type occurs along slopes and in swales not adjacent to well-defined stream channels. Black, white, and post oak are the most abundant trees, with some blackjack, honey locust, walnut, elm, hawthorn, wild cherry, and wild plum. The type ranks high as an agricultural soil. Corn and grass do especially well. Corn ordinarily yields from 25 to 40 bushels, and oats, on the average, about 30 bushels per acre.

Tilsit silt loam.—The soil is a pale yellow to brownish-yellow silt loam, often gray in the upper 2 or 3 inches. The subsoil is pale yellow to brownish yellow, with a faint reddish tinge. From 10 to 24 inches the subsoil is slightly heavier than the soil and often has a somewhat lighter color. Below 24 inches it is a mottled yellow, gray, and brown. The surface soil differs from the Hagerstown in being a yellow rather than a brown soil, though they graduate into each other. More or less fine or very fine sand is occasionally present. The type is derived from fine-grained sandstone interstratified with limestone. It is influenced more or less by material from the limestone of higher areas. The general farm crops give fair to good yields.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Clarksville silt loam	Alabama 19, 23, 26; Arkansas 2; Kentucky 4, 7; Missouri 4, 6, 7, 9, 11, 18, 22; Tennessee 1, 3, 7, 9, 10, 12.	1,733,762
Hagerstown silt loam	Georgia 18; Kentucky 4; Missouri 4; Pennsylvania 2, 5, 8; Tennessee 1, 12; Virginia 9.	317,632
Decatur silt loam	Alabama 10; Missouri 5; Tennessee 3, 12	72,128
Colbert silt loam	Alabama 10, 20, 26	51,264
Tilsit silt loam	Missouri 4	39,168
Baxter silt loam	Missouri 6; Wisconsin 7	27,648
Pocahontas silt loam	Missouri 4	23,616
Guthrie silt loam	Alabama 10, 35; Kentucky 4; Missouri 5; Tennessee 1, 3, 10, 12.	9,216
Murrill silt loam	Pennsylvania 2	8,704
Brooke silt loam	Pennsylvania 18	7,616
Senlon silt loam	Missouri 11	6,528
Locust silt loam	Alabama 15	4,992
Total		2,302,274

[1] For key to numbers in this column see p. 733.

STONY SILT LOAM PHASE.

The stony silt loams are represented in the Limestone Valleys and Uplands province by a single type, the Decatur stony silt loam. The soil material of this type is identical with the Decatur silt loam, but the surface configuration is more uneven, and there is present a sufficient quantity of chert fragments to make the land considerably more difficult to till. Where the surface is not too rough and the stones not too abundant, good yields of the general farm crops are secured.

Decatur stony silt loam.—The type consists of a dull red loam from 6 to 12 inches deep, underlain by a red clay loam or clay. The soil contains from 10 to 30 per cent and the subsoil from 20 to 50 per cent of angular chert fragments. The type is friable and easily worked, except where the stone content is excessive. The topography is rolling and drainage good. The type is especially suited to wheat, grasses, and corn. Fruit does well.

Area and distribution of the stony silt loam.

Soil name.	State or area.[1]	Acres.
Decatur stony silt loam	Missouri 5	15,872

[1] For key to number in this column see p. 733.

CLAY LOAM GROUP.

The clay loam soils are of relatively small extent in this province. They are more difficult to work than the members of the lighter textured groups and require a heavy farm equipment and strong teams. Unless carefully managed the sloping areas erode badly. The steepest slopes should be used for the production of hay, or when cultivated seeded to soil-binding crops, including, especially, winter cover crops. A good organic-matter supply should be maintained in all of the types, both to check erosion and to counteract the tendency of the material to bake in dry weather. These soils must be cultivated within a much narrower range of moisture conditions than any of the lighter-textured soils. If plowed too wet they puddle and bake with subsequent dry weather, forming clods when plowed. Grazing when the soil is sufficiently wet to be miry is also likely to bring about this unfavorable structure.

Much of the clay loam land represents areas of originally light-textured soils which have had the top layer partly worked off, bringing the heavier clay subsoil near the surface, where it has been partially mixed with the original lighter material.

Corn, oats, wheat, grass for hay, cowpeas, clover, and tobacco are the crops generally grown. Cotton gives good results in the southern areas, while apples and peaches do well, especially on the types derived from pure limestone, such as the Decatur, Hagerstown, and Brooke members of the group. Strawberries are generally successful.

The Decatur clay loam is the most extensive member of this group, occupying considerable areas in Alabama, Georgia, Tennessee, and Virginia.

The Hagerstown clay loam occupies a moderate area, occurring in scattered bodies, especially in the valleys of Pennsylvania and Virginia. In adaptation to crops this type is practically identical with the Decatur clay loam.

The Brooke clay loam is mainly confined to the eroded uplands of West Virginia and southwestern Pennsylvania.

The other members of the group have a rather patchy development in the valleys and uplands division of the province.

Brooke clay loam.—The surface soil is a brown or dark-brown, heavy loam or clay loam from 6 to 10 inches deep. The subsoil is a light-brown clay which grades into a slightly yellowish, heavier clay at a depth of 20 inches. Continuing to a depth of 3 feet or more the texture remains a heavy clay, but the color becomes lighter, sometimes becoming gray or drab. Small fragments of gray or bluish-colored limestone and calcareous shale are scattered over the fields and disseminated through both soil and subsoil, occasionally outcropping in road cuts. On narrow ridges, where the surface soil has been removed by erosion, the rock fragments are more noticeable, and the surface material is apt to be a clay. The soil is derived from the disintegration of limestone rock and calcareous shales. Where well developed the type is gently rolling to moderately hilly. A large part of it is under cultivation, and is recognized as valuable for general farming. Corn, oats, wheat, timothy, clover, and bluegrass are the principal crops. Apples, cherries, plums, raspberries, strawberries, and garden vegetables are grown for home use and to some extent for market. Bluegrass comes in as the timothy thins out and is very valuable for grazing purposes. Very few potatoes are grown, the soil being considered too heavy for this crop.

Clarksville clay loam.—The soil is a brown to reddish-brown silty clay loam to clay loam about 8 inches deep. It is underlain by a heavy red silty clay loam or clay loam extending to a depth of 3 feet or more, the clay content increasing in the lower portion. The type occupies gently undulating country and is usually well drained. It is a deep residual soil derived from the decomposition of limestone. The soil is strong and fertile, and is considered excellent for general farm crops. Tobacco of the export variety produces a heavy yield, though the crop is of inferior quality.

Colbert clay loam.—The surface soil of this type consists of a heavy, gray silty clay loam or clay loam underlain at a depth of about 6 inches by a mottled gray or grayish-yellow clay. The topography varies from flat to undulating and the natural drainage is rather deficient. It is derived from limestone. When well drained it is adapted to the general farm crops.

Decatur clay loam.—The soil of the Decatur clay loam, to a depth of 8 to 12 inches, consists of a brown to reddish-brown, friable loam. In local eroded spots it is red and shallow and approximates in texture a clay loam, while in the slight depressions it is darker, mellower, and deeper. The subsoil, to a depth of several feet, is a reddish-brown to red clay, practically free from stone fragments. Where the soil is deepest the subsoil usually grades through a brown clay loam into a clay at an average depth of 18 inches. Local outcrops of limestone occur, but are not numerous enough seriously to interfere with cultivation. The topography is gently rolling. The type owes its origin mainly to the decomposition of limestone and Knox dolomite. Nearly all of it is under cultivation. It produces good crops of corn, wheat, oats, cowpeas, and sorghum. Apples thrive when given proper care.

Fort Payne clay loam.—The surface soil is a compact gray to light-yellow loam to silty loam about 10 inches deep, with an ashy feel. The subsoil is a heavy yellow clay loam, grading rapidly into a stiff, sticky, impervious yellow clay which, in the lower depths, is often mottled with red. The type occupies high hilly to gently rolling areas. It is of residual origin, being derived from the weathering of a series of rocks consisting of sandy to argillaceous, calcareous shales, shaly limestone, and impure limestone. It occupies hilly to gently rolling areas. The soil is difficult to work and becomes hard when dry. It is best suited to grasses and pasturage.

Hagerstown clay loam.—The type consists of a reddish clay loam or silty clay loam from 10 to 24 inches deep, underlain by a stiff, tenacious red clay. It occupies rolling valley land, and is derived from the weathering of pure, massive limestones. This type is recognized as one of the strongest soils for general agricultural purposes and is well known for its large crops of wheat and corn.

Hollywood clay loam.—The type consists of a black or dark-brown clay loam, underlain at 12 to 13 inches by a tough, plastic, yellow clay, faintly mottled with shades of brown and with black oxide or iron. In places the subsoil has a drab color, which frequently is encountered as an upper subsoil layer or very thin stratum between the soil and lower yellow subsoil. Black oxide of iron concretions occur in large quantities on the surface and throughout the soil section. The type is derived from lime-

stone and occupies flat or slightly depressed situations in the valleys, where imperfect drainage has resulted in the accumulation of dark-colored organic matter in the soil. Corn yields from 35 to 45 bushels per acre, oats from 20 to 30 bushels, and wheat 10 to 15 bushels. Cowpeas, millet, and grass do well.

Murrill clay loam.—The soil is a yellowish-brown clay loam about 10 inches deep, underlain by a yellow clay loam, the clay content increasing with depth. Both soil and subsoil contain small fragments of shale and chert. The material is derived in part from limestone and in part from sandstone and shale, the latter material usually representing continued surface accumulations from adjacent slopes. The type occupies lower slopes and undulating valley lands near lighter areas of sandstone and shale soils.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Decatur clay loam	Alabama 3, 6, 15, 20, 21, 26, 28, 35; Georgia 18; Tennessee 1, 4; Virginia 9.	282,240
Hagerstown clay loam	Alabama 20, 28; Pennsylvania 2, 3, 5, 8, 9; Virginia 9	139,784
Clarksville clay loam	Alabama 26; Kentucky 7; Tennessee 9	102,084
Brooke clay loam	Pennsylvania 18; West Virginia 4, 6, 7, 8, 10	50,240
Murrill clay loam	Virginia 3	15,720
Fort Payne clay loam	Tennessee 5	9,536
Colbert clay loam	Alabama 10	3,136
Hollywood clay loam	Alabama 26	1,920
Total		604,660

[1] For key to numbers in this column, see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loam soils of this province are of secondary importance, only two types having thus far been recognized. These soils, like the clay loams, require a heavy farming equipment for their proper cultivation. They are somewhat more inclined to bake in dry weather than the clay loams, but less inclined to clod. Liberal additions of vegetable matter and applications of lime help materially in maintaining a desirable condition of tilth. Corn, grass, clover, and wheat give good results.

Colbert silty clay loam.—The soil is a grayish, compact, heavy silt loam to silty clay loam, about 5 inches deep. The subsoil is a heavy, yellow, silty clay loam usually grading into a plastic, silty clay, frequently sticky and tenacious in the lower parts. The type is derived from pure limestone modified in places by sandstone. The topography varies from flat to gently undulating with drainage imperfectly established. The principal forest growth consists of red, post, and blackjack oak, hickory, pine, and elm. The type is adapted to shallow-rooted crops, such as wheat, grass, and lespedeza.

Decatur silty clay loam.—The surface soil is a dark reddish brown to chocolate-red, silty clay loam from 5 to 18 inches deep, underlain by a blood-red or dark-red clay, becoming compact in the lower section. The soil is quite mellow and works up readily into a good seed bed. The type is derived from limestone. It occupies the smooth portions and slight depressions of the limestone valleys. The soil is of high agricultural value and adapted to cotton, corn, clover, oats, wheat, cowpeas, and grass.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Colbert silty clay loam	Alabama 20, 26, 28; Georgia 18	39,808
Decatur silty clay loam	Alabama 26	38,976
Total		78,784

[1] For key to numbers in this column, see p. 733.

CLAY GROUP.

The clays of the Limestone Valleys and Upland province, from the surveys made, occupy a slightly larger area than the clay loams. They are the most difficult soils of the province to cultivate, requiring the heaviest farm equipment for the main-

tenance of a good condition of tilth. Like the clay loams, the sloping areas suffer severely from erosion and should be used either for hay crops or fruit. Many of the areas represent eroded portions of lighter textured soils. Deep fall plowing, the frequent turning under of vegetable matter, and liberal additions of lime are necessary to maintain the soil in a mellow, open condition of structure and enable it to resist erosion. The range in moisture conditions under which these soils can be worked is narrow. The soils are puddled easily if plowed when wet enough to be sticky and harden with subsequent dry weather, while clods are turned up if the land is plowed in this condition. Grazing, when the land is wet, also tends to bring about a compacted condition.

The general farm crops, particularly wheat, grain, grass for hay, and tobacco, constitute the most profitable type of agriculture on these lands. Apples and peaches succeed on the better-drained types.

The Hagerstown clay is by far the most important member of the group and occurs throughout the valley division. If properly handled it is a productive soil, being equalled only by the Decatur clay, which has a small development in the southern section of the valleys.

Large areas of Conestoga clay occur in various parts of the valley region. This type owes its characteristics to the greasy nature of the subsoil, resulting from the presence of fine particles of mica derived from the parent limestone. The soil is adapted to general farm crops, but is not so productive as the Hagerstown and Decatur types.

The other members of the group have not been encountered in sufficiently extensive areas to constitute very important soils.

Colbert clay.—The soil is a dark-gray, heavy, sticky clay about 6 inches deep, underlain by a heavy yellow and gray mottled plastic clay. The type is residual in origin and derived from limestone. The topography is flat or undulating to sloping. The slopes are well drained, but over the more nearly level areas drainage is often poorly established. The soil is somewhat refractory, but under careful management it produces good yields of corn and alfalfa.

Conestoga clay.—This type consists of a yellowish to dark-brown clay loam about 7 inches deep, underlain by a yellow to reddish-yellow, tenacious clay, ordinarily about 24 inches deep. The substratum consists of partially decomposed schistose limestone. On ridges bedrock is usually found at an average depth of 10 inches. The type occupies the lower and gently rolling portions of the valleys. The higher areas are well drained. The soil is residual in origin and derived from schistose limestone. Wheat and grass are the principal crops.

Decatur clay.—The soil consists of 4 to 6 inches of reddish-brown clay loam or friable clay, underlain by a stiff, red clay. At various depths below 18 inches massive limestone rock from which the type is derived is encountered. The surface is moderately rolling to hilly or broken. Rock ledges and large rock fragments on the surface are common, with occasional sink holes. Drainage is good. Cedar thrives in the more stony locations. This is an excellent upland soil for general farming where no stones are present. Clover and bluegrass do well.

Guthrie clay.—The surface soil is a light-gray to nearly white, silty clay to silty clay loam, about 7 inches deep. The subsoil is a heavy, plastic, and impervious silty clay, varying in color from gray to drab, mottled with yellowish iron stains. The type occupies low, flat areas on the uplands and is derived from limestone. On account of its low, wet situation it is of little agricultural value unless artificially drained. In favorable seasons corn and tobacco are grown. The type is largely covered by hickory, sweet gum, and oak, and the type is generally known as "crawfish land." Certain grasses succeed on the type.

Hagerstown clay.—The soil is a heavy, brownish to reddish-brown clay ranging from 5 to 12 inches in depth. The subsoil is a stiff, tenacious, reddish-yellow or red clay. The type occupies rolling valley lands and is derived from the weathering of pure, massive limestone. This is recognized as a strong soil for general farm crops. Certain varieties of apples do well.

Hollywood clay.—The soil to a depth of 10 to 12 inches is a dark-gray to black, stiff, intractable clay. The subsoil is a dark-gray to yellowish, sticky, plastic, heavy clay, often mottled at lower depths with gray, yellow, and sometimes red. Black oxide of iron concretions occur in the subsoil. The type is developed in the flat areas of limestone valleys, often occurring near drainage ways. It is a limestone soil and of only moderate agricultural value. Owing to its heavy texture and plastic structure, cultivation is difficult unless conducted at the proper time with respect to moisture content. Corn and grass give fair results.

Pennington clay.—The soil is a yellow to light-brown clay of variable depth. The subsoil is a tough, yellowish clay mottled with light blue. Throughout a large part of the year a soggy condition exists caused by seepage waters. A thin covering of

colluvial material is encountered in places. At present the type is not used for agriculture, as it requires artificial drainage before any crops can be grown.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Hagerstown clay	Alabama 16, 19; Georgia 18; Kentucky 2, 3, 5; Pennsylvania 5, 9; Tennessee 5; Virginia 1, 3; West Virginia 3.	363,546
Conestoga clay	Tennessee 5; Virginia 1	64,128
Guthrie clay	Alabama 19, 23; Kentucky 2; Tennessee 9	20,584
Decatur clay	Tennessee 4	15,040
Colbert clay	Alabama 10	1,408
Hollywood clay	Alabama 20	1,088
Pennington clay	Kentucky 4	256
Total		466,050

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

Only small areas of the stony clay phase have been found in the limestone province. The soil material is similar to that of the corresponding clay type, but the soils usually give lower yields on account of their stone content or rough topography. They are adapted to the same crops as the clay types.

Colbert stony clay.—The soil is a gray to grayish-brown, compact, silty clay loam to silty clay, from 4 to 6 inches deep. The subsoil is a plastic, sticky yellow clay. Ledges or fragments from which the type is derived, are of common occurrence. The type comprises flat to undulating valley lands and lower slopes. Oak, cedar, and hickory constitute the principal timber growth. This is a difficult soil to plow, and is best suited to the production of grass for hay or pasturage.

Hagerstown stony clay.—The soil consists of a brown to yellow clay loam or clay about 8 inches deep, underlain by yellowish to red clay. Large quantities of limestone fragments are found in both soil and subsoil, while outcrops of hard limestone are of frequent occurrence. The surface is generally stony. The type occupies sloping to hilly areas, consisting of ridges and valley slopes. The soil owes its origin to the weathering of limestone and shaly limestone, influenced in some areas by colluvial sandstone and shale material. Sandstone and shale fragments fallen from adjacent slopes occur in places. The soil is naturally productive, but the large quantity of rock fragments and rock outcrops make but little of it available for cultivation. Fair yields of corn, cotton, and forage crops are secured on the less stony areas.

Area and distribution of the stony clays.

Soil name.	State or area.[1]	Acres.
Hagerstown stony clay	Alabama 4, 15; Kentucky 2; Tennessee 4	55,808
Colbert stony clay	Alabama 20, 28; Georgia 18	10,368
Total		66,176

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough stony land	Alabama 20, 26; Missouri 5, 8, 11, 22; Tennessee 1, 3, 12	378,368
Rock outcrop	Missouri 11	1,280
Total		379,648

[1] For key to numbers in this column see p. 733.

Revision of September, 1912.

Key to the Soils of the Limestone Valleys and Uplands Province.

- Pure limestone
  - Black soil
    - Dark gray to [illegible] subsoil occasionally mottled with red
      - Sticky plastic structure
        - Hollywood
  - Brown soil
    - Light brown to reddish brown subsoil
      - Rock outcrops common
        - Hagerstown
      - Abundant angular chert gravel in lower subsoil
        - Colluvial slopes
          - Senlon
    - Yellow subsoil
      - Residual crest of hills and ridges
        - Frocke
  - Red soil
    - Intense red subsoil
      - Decatur
  - Gray soil
    - Yellow to dull red subsoil
      - Substratum red
        - Abundant chert usually calcareous
          - Clarksville
  - White soil
    - Mottled yellow and gray subsoil
      - Iron concretions
        - Poor drainage
          - Guthrie
- Siliceous and argillaceous limestone
  - Gray soil
    - Yellow to reddish brown subsoil
      - Abundant non-calcareous chert
        - Baxter
    - Yellow subsoil
      - Abundant light colored hard flinty and yellowish soft rock fragments
        - Frankstown
  - Yellow soil
    - Yellow subsoil
      - Substratum chert gravel
        - Locust
- Limestone, sandstone and shale
  - Brown soil
    - Yellow subsoil
      - Pocahontas
      - Colluvial slopes (Includes material from igneous rocks in Blue Ridge belt)
        - Murrill
    - Yellow to reddish subsoil
      - Alternating shales and limestone beds
        - Duffield
  - Gray soil
    - Reddish yellow plastic impervious subsoil
      - Substratum mottled red and white cherty
        - Fort Payne
  - Yellow soil
    - Mottled yellow and blue stiff clay subsoil
      - Pennington
- Limestone and sandstone
  - Gray soil
    - Yellow subsoil often plastic
      - Colbert
  - Brownish yellow to gray soil
    - Brownish yellow subsoil
      - Deep subsoil mottled yellow, brown and gray
        - Tilsit
- Schistose limestone
  - Yellowish brown soil
    - Yellow subsoil
      - Micaceous
        - Greasy feel
          - Conestoga
- Limestone conglomerate
  - Brown soil
    - Light brown subsoil
      - Hagerstown and Penn. [illegible]
        - [illegible]

SOILS OF THE GLACIAL AND LOESSIAL PROVINCE.

By J. E. LAPHAM and CURTIS F. MARBUT.

DESCRIPTION OF THE PROVINCE.

The Glacial and Loessial soil province includes that part of the United States lying east of the Great Plains in which the soils are derived from: (1) Ice-laid deposits left by the retreat of the ice at the close of the Glacial Period; (2) water-laid material intimately associated with the ice-laid material, deposited during the advance and retreat of the ice in the form of outwash plains; (3) silt deposits laid down by water or wind during or subsequent to the retreat of the ice.

BOUNDARIES.

The northern boundary of the province is the international boundary from Maine to Montana. The eastern boundary from Maine to New York City is the Atlantic Ocean. The southern boundary extends from the Narrows in New York Harbor in a general northwesterly direction across New Jersey and Pennsylvania to the vicinity of Salamanca, N. Y., thence in a southwesterly direction across the northwestern corner of Pennsylvania to the Ohio-Pennsylvania line, a few miles southwest of Newcastle, Pa. It continues westward to the vicinity of Millersburg, Ohio. From this point it trends southward to the Ohio River about 20 miles below Portsmouth, following that stream downward, crossing to the south side a short distance below Cincinnati, thence in a southwesterly direction to Crittenden County, Ky., inclosing a narrow belt of loessial deposits between it and the river. From Crittenden County, Ky., it follows a course roughly paralleling the Mississippi River and including a strip of country from 10 to 40 miles wide between it and the bluffs on the east side of the river bottom lands, the belt terminating a few miles northwest of Lake Pontchartrain, La.

Opposite this southern extension of loessial material small patches of loess deposits occur on the west side of the Mississippi, but there is no continuous belt south of the confluence of the Osage and Missouri Rivers. Throughout this belt, therefore, the eastern bluffs of the Mississippi and the northern bluffs of the Missouri may be considered as the boundary of the province, the small areas occurring east of it being merely outliers.

From the mouth of the Osage River in Missouri the boundary line parallels the Missouri River westward to Kansas City, thence into Kansas a few miles west of Topeka, thence northwestwardly crossing the State line in Washington County, Kans., and continuing in a general northerly direction to the junction of the Niobrara and Missouri Rivers. It follows the general course of the latter river through South Dakota, but in North Dakota crosses to its western bank, continuing in a northwesterly direction to about 30 miles west of Bismarck and following a course generally parallel to and a few miles south of the Missouri, approximately, to the boundary of the Great Plains in Montana.

From the point where the boundary is described as crossing the Kansas-Nebraska State line, a lobe swings to the southwest, covering a large proportion of the western part of Kansas and extending into the Panhandle of Oklahoma. The western and northwestern boundary of this lobe follows approximately the Kansas-Colorado State line to the extreme northwestern corner of Kansas, and thence in an irregular northeasterly line through Nebraska to the mouth of the Niobrara River. The material embraced in this area is of a loessial nature, although the soils are classified with those of the Great Plains region, and the area is not included in the glacial and loessial province on the map.

The ice-laid deposits are found north of an irregular line running from Cincinnati to La Crosse, Wis., thence southward to Iowa City, Iowa, continuing in a westerly direction to the southeastern corner of South Dakota. South of that line they are mainly loessial, presumably wind-laid deposits. The two tongues, the one running down the Mississippi and the other southwestward across Kansas and Oklahoma, are entirely so.

PHYSIOGRAPHY.

The general physiography of the area included in the Glacial and Loessial province is essentially the same as that of the country adjacent to it on the south and west. Although the deposits made within this area by the ice, water, and wind are in many places thick, they are not thick enough to obscure the broad topographic features of the region. All the essential features of the Appalachian pass from the extra-glacial region into the glacial region practically without change. The Interior Lowlands, Allegheny Plateau, Appalachian Ridges, the Great Valley, the Highlands, expanding northeastward into the New England upland, the Piedmont Plateau, and even the Coastal Plain are as distinct physiographically within the Glacial and Loessial province as they are south of it.

It is only in the details of the topography that the deposits have modified the appearance of the country. Valleys have been filled up and country that was originally rough has been made smooth.

Little effect on the topography, however, even in local detail of relief was caused by the wearing down of mountains and ridges. These were rounded in their outline and the disintegrated rock material taken off, but there was probably very little reduction of the rock surface by the ice. The general, almost universal effect of ice action in the United States was to reduce the local relief, to make the surface smoother than it was before the glacial period.

Topographically, therefore, the whole area may be divided into three main areas, a western, eastern, and a coastal area, known as the Interior Lowland area, the Appalachian area, and the Atlantic Coastal area.

THE INTERIOR LOWLAND AREA.

The Interior Lowland area includes all the territory lying west of the Allegheny Plateau, whose western boundary coincides with that of the province from the Ohio River to the sharp point where it makes a bend in Central Ohio; thence it runs northeastward in an irregular line to the Glacial Lake boundary, a few miles west of Ashtabula, Ohio.

Leaving the hilly lands lying along the large streams of the region out of consideration for the moment, this area consists topographically of two sections: (1) A southern smooth, often nearly flat, portion, and (2) a northern more rolling and sometimes hilly portion. There is no sharp boundary between these areas, although a line from Crookston, through Minneapolis, La Crosse, the southern peninsula of Michigan, through Jackson, would divide approximately the more rolling northern country from the smoother southern and western country. Even in the latter area, however, the part that is too rough for agricultural utilization is small. It occurs in northern Minnesota, northern Wisconsin, and the northern peninsula of Michigan.

That part of the area lying south of the broken line dividing the area that is mainly loessial from that mainly glacial is smoother than the northern part. Large areas of southern Ohio, Indiana, southern Illinois, northeastern Missouri, and southeastern Iowa are almost featureless plains, except where broken by the shallow valleys of the creeks that traverse them. The rest of the area, not including the river hill belts, is gently rolling to undulating, an extremely small proportion of it being too rough to cultivate. The northern fringe of the southern belt has a topography essentially as it was when the ice left it. The southern part has suffered somewhat more from erosion than has the northern. Where erosion has not affected them, however, they are smoother than the northern area, since originally they consisted of flat plains.

The belts of country lying along both sides of the large rivers, such as the Ohio, Mississippi, and Missouri, and half a dozen smaller streams, are usually thoroughly dissected and therefore hilly. Portions of these hills are too rough for easy cultivation, and when cultivated erode badly. These belts vary considerably in width, extending in each direction from the bottom-land boundaries for distances varying from 2 to 20 miles, with an average of nearly 10 miles. The predominant soils occurring in this smoother southern belt are the Marshall, Knox, Lexington, Memphis, and Putnam.

The Knox soils occupy the more rolling to hilly areas, especially the river hill belts, all lying north of the mouth of the Ohio. South of that the predominant soils are the Memphis, which are best considered as southern representatives of the Knox series.

The Marshall, Putnam, and Lexington soils are the predominant soils on the smoother areas.

From central South Dakota to the southeast this belt includes the great corn belt of the United States. This is a general farming region in which corn is the predominant crop, with clover and timothy as the important hay crops and oats as the important small grain. Its live stock consists mainly of hogs and the beef breeds of cattle, the live-stock industry being confined largely to the fattening rather than the raising of animals. This is also a belt of predominantly high-priced lands in the United States.

A large part of this area, especially that section lying west of Indiana, consisted originally of treeless plains, requiring no laborious work in removing a heavy timber growth before the land could be cultivated. The conditions favored a rapid occupation of the country by white men, and the great natural fertility of the soil assured heavy yields from the start. It was settled and placed under cultivation with phenomenal rapidity.

The northern belt of the Interior Lowland area is somewhat rougher in topography than the southern. Very little of it, however, is too rough, so far as land relief is concerned, for cultivation. It differs in several respects from the southern belt, all of which are of importance as affecting its agriculture:

(1) This is a region in which ice-laid surface material predominates. The silty mantle covering a large part of the surface in the southern belt is here absent, and the soil is derived directly from the bowlder deposits. The soil contains, therefore, a much greater percentage of stones and bowlders than in the southern area, a feature which makes much of it unfit for cultivation.

(2) The water-laid drift, like the ice-laid drift, is also without the silty covering, and a considerable proportion of the soil is derived from such material. This is usually sandy or gravelly and more or less droughty.

(3) Combining 1 and 2 into one statement, the soils of the northern belt are less uniform over large areas, are more sandy, gravelly, and stony than the southern belt, and the topography is more irregular and somewhat rougher.

(4) Practically the whole area was covered with a heavy growth of timber at the time of the occupation of the region.

(5) The climate is less favorable for agriculture than in the southern belt.

All of these factors have retarded the occupation of the region, much of which is still unutilized for agricultural purposes. The main crops are small grains, potatoes, vegetables, forage crops, and corn, the latter being much less important than in the southern belt. The live-stock industry is a dairy and stock raising industry rather than a stock-fattening industry.

As a result of the rougher and more varied topography and the varied soils within a given area arising from the absence of the silty mantle that covers these deposits in the southern belt, there are no large areas in which one or two soil series predominate. The Miami, Coloma, Kewaunee, and Carrington soils are the most important in the belt, but no one of them occurs in such large and unbroken areas as does the Knox and Marshall in the southern belt.

THE EASTERN AREA.

The whole of the province east of the Interior Lowland area is included under this head except the small Coastal Plain area on Long Island, Cape Cod, and intermediate islands.

It consists physiographically of several areas, each corresponding to a similar physiographic belt south of the Glacial Province which extends across the boundary line unmodified except as to the details of its relief and the character of the soils.

These physiographic areas or belts are: (1) The Allegheny Plateau; (2) the Appalachian Ridges; (3) the Great Valley; (4) the Highlands of New York and New Jersey, the Adirondack Mountains of New York, and the New England Plateau; (5) the Piedmont Plateau.

THE ALLEGHENY PLATEAU.

The Allegheny Plateau occupies the southwestern part of the eastern area extending from the eastern boundary of the Interior Lowland to the Helderberg-Catskill-Allegheny Front Escarpment in Eastern New York and northward to the southern boundary of the Lowland belt lying south of Lake Ontario. It is, therefore, typically a feature of southern New York, extending into adjacent

parts of Pennsylvania and into eastern Ohio. As a whole it is a high plateau deeply and thoroughly dissected by the drainage. It is highest along its eastern boundary, reaching a maximum elevation of 4,000 feet, and slopes gently westward to about 1,500 feet in its extreme western part. The roughness of the topography is determined by the depth and thoroughness of the dissection and the steepness of the slopes. The former is determined by the elevation of the plateau top, the size of the streams, and the distance to the sea along the streams within any given locality. There are two relatively smooth belts within the plateau. One of them runs in a northeasterly direction across western Pennsylvania and into western New York from the southwestern part of the latter State to the northern boundary of the plateau south of Buffalo. The southern part of this belt is due to the outcropping of a series of soft shale and limestone beds and the northern end to the shallow dissection on the upper headwaters of the Allegheny River drainage system.

The other and smoother belt lies in a north and south position in the Finger Lake region of New York, extending southward into Tioga, Bradford, and Susquehanna Counties, in Pennsylvania. It is due to the rounding of the slopes in the Finger Lake region, possibly by the glacial ice, and to the outcrops of a series of shales and soft sandstones in the extension of the belt south of the Finger Lakes.

The extreme western side of the area is considerably lower than the eastern part, and does not stand so high above the broad valleys that traverse it in that region. This part, as well as the smoother belts described above, are largely under cultivation. The rougher parts are cultivated on their smooth areas, but the proportion of cultivated land is much smaller than in the smoother belts.

The geological formations belong to the Devonian and Carboniferous systems. The rocks are predominantly sandstones and shales. The southern or Pennsylvania end of the western belt of smoother country is underlain by a series of alternating shale, sandstone, and limestone beds, all somewhat softer than the sandstone beds in the adjacent higher and rougher areas. The rest of the area is underlain by sandstone and shales varying considerably in resistance, but over all the rougher area the surface is underlain by resistant beds of sandstone. It is therefore predominantly a sandstone region. The beds of rock lie nearly horizontal as a whole, the variation from that attitude consisting of a gentle southwestward dip and local folds at a few places within the area.

The predominant soils belong to the Volusia series. Associated with these in the eastern part of the area are the Lackawanna soils.

Agriculture in the whole region is in a state of decline, or at least of stagnation, and has been in this condition for some time. The topography is rough, the soils are only moderately fertile, and the region lies near the larger cities of the country, in which growth has been rapid during the last few decades. These factors have contributed to the decline of interest in agriculture. The crops best adapted to this region are timothy, potatoes, oats, barley, rye, and corn, in the order named.

THE APPALACHIAN RIDGES.

This belt consists of a series of parallel ridges and intervening lowlands, the former narrow, linear, steepsided, and varying in elevation from 500 to 800 feet above the latter, which are usually hilly.

Only one of the important ridges and its adjacent lowland belt extends for any considerable distance into the province, aside from the two ridges and the inclosed Wyoming Valley, in Pennsylvania, which extend from the south across the boundary for a few miles into the Glacial and Loessial Province. The ridge referred to is the Kittatinny Mountain, in New Jersey, and its northern extension, known as the Shawangunk Mountain, in New York. It is practically nonagricultural. On the gentler slopes there is some attempt at cultivation, though so little in the aggregate as to scarcely merit mention in a general statement. The soils are mainly Rough stony land—Lackawanna and Culver series.

The lowland belt, lying parallel to and along its western side, comprises hilly lowlands and averages about a mile in width. It is occupied by the Delaware River from the province boundary northward to Port Jervis, N. Y., and to the northeast from that point by small streams only. Very little soil-survey work has been done in this region and little is known of its soils. The only series of considerable extent so far encountered in it is the Wallpack. The belt merges into the Hudson lowland in the vicinity of Rosendale.

THE GREAT VALLEY.

The Great Valley region includes the lowland belt lying between the Appalachian ridges, or where these do not occur, as in the case north of Kingston, N. Y., the Allegheny Front on the west and north and the Highlands of New York and New Jersey and the New England Plateau on the east. It includes the Hudson-Champlain Valley, the Mohawk lowland belt, and the lowlands south and east of Lake Ontario, except those areas covered by lake deposits.

This area is topographically an undulating to hilly, lowland belt. Its elevation along the Hudson-Champlain belt ranges from 100 to 900 feet above the sea level, the higher areas lying along the eastern side. The Mohawk belt, throughout its whole extent from Schenectady, where it opens into the Hudson belt, to Utica, where it opens into the Ontario plain, is rougher than any other part of the whole lowland area. Its elevation reaches a maximum of some 1,500 feet and it is everywhere thoroughly dissected, though its slopes are rounded rather than angular.

The Ontario Plain region is smoothest of all the area. It consists essentially of a smooth, nearly flat plain with a large number of low, elliptical, smoothly rounded hills standing on it. Practically all of its surface is capable of cultivation.

In the western part of the New England Plateau there are a number of lowland belts and areas with a north and south trend which are essentially outlying areas of the Great Valley lowland. They are rolling to hilly in topography. A number of small areas occur in western Connecticut, the Pittsfield Valley in western Massachusetts, and the Rutland-Bennington belt in Vermont. All of these belong in the same series.

The Hudson-Champlain belt of the Great Valley lowland is underlain by two formations, a thick bed of shales, unchanged in part, indurated in part, and metamorphosed to slate in part, and a series of limestones. The latter are usually crystalline. The New England areas are underlain by limestone, presumably the same bed that occurs in the Hudson-Champlain belt.

The Mohawk belt is underlain mainly by shales on the north side of the river and by shales, sandstones, and a few thin beds of limestone on the south side.

In the Ontario Plain the glacial deposits are usually thick and the material has been brought from distant regions to the northward in Canada. The underlying rocks consist of red sandstones, shales, and limestone beds, and where the drift cover is thin this material enters into the soil as an important factor. Where the drift is thick the proportion of local material is less. As a whole it may be said that the greater part of the soils of this plain are derived from crystalline rocks, limestones, and red sandstones.

The predominant soils of the New England areas and the Hudson-Champlain belt belong to the Dover and Dutchess series. In the Mohawk belt they are more varied and the Dover soils seem to be lacking. The Dutchess, Allis, and Mohawk soils, with more or less Volusia material, make up the main body of the soils. In the Ontario Plain the predominant soils are Ontario.

Throughout all the belts general farming, with hay and small grains, not including corn, though this crop is also grown, is the rule, with dairying receiving considerable attention. Locally the cultivation of small fruits and vegetables and potatoes receives considerable attention. It is not, however, a region of intensive farming. Agriculture has suffered no noticeable decline in recent years, except over local areas.

THE HIGHLANDS, ADIRONDACKS, NEW ENGLAND PLATEAU.

This term is used to include the Highlands of New Jersey and New York, the Adirondacks, the whole of New England, except Cape Cod, the offshore islands, and the Connecticut Valley lowland.

The topography is generally rough and the soil stony. The southern part of the area consists of a plateau, highest in the northwestern part and sloping southeastward to the sea in New England and toward the steep slope separating this area from the Piedmont belt in New York and New Jersey.

The plateau surface has been thoroughly dissected by valleys, not merely by narrow branching valleys, as in the Allegheny Plateau, but by valleys of all degrees of width, shape, and regularity or irregularity of feature. There is not only no uniformity of features in different valleys, but the same valley

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may vary greatly in width, depth, shape, and slopes in different places. The topographic details cut into the plain have no regularity of form, a condition which has been emphasized by the glaciation to which the region has been subjected and manifested by diversion of rivers from their courses and by the formation of lake basins. The slopes, however, are rather rounded, and on the basis of steepness of slope alone a larger proportion of the land can be cultivated in this belt than in the rougher parts of the Allegheny Plateau.

In northern New England the topography is rougher than in the southern part, much of it being mountainous and entirely too rough to cultivate. In this part of the area the mountains stand above the level of the plateau in the southern part. Some of the smaller, isolated masses extend into Massachusetts, but they do not constitute a large proportion of the country. Even in the northern part large areas can be utilized for agriculture, though there is relatively little smooth land. In the Atlantic coast belt of Maine there are considerable areas of marine silts and clays which have a smooth topograpy.

The rocks underlying the whole area consist of gneisses, schists, granite, and other metamorphic and igneous formations, with small areas of limestones, found mainly in eastern Maine. The glacial mantle varies greatly in thickness, but it is everywhere made up mainly of crystalline material and is uniform over larger areas.

The predominant soils are the Gloucester soils on the uplands, the Merrimac soils on the smooth outwash plains and terraces, and the Caribou on the marine deposits of the northeastern section of the area.

The agriculture of the region up to half a century ago was generally grain. hay, and live-stock farming. Western competition has latterly made such a system unprofitable on these rough lands, and coupled with the growth of the large cities has caused the abandonment of large sections of this type. In recent years, however, interest is being revived in the agriculture of the region, taking the form of increased attention to special crops, such as apples, potatoes, peaches, small fruits, and vegetables. Dairying, the form of farming that bridged the gap between the old system and the developing new system, continues to maintain a considerable importance. It must continue to do so in the future, since the soils are well adapted to grazing and the hay grasses. Potato growing in Maine is the best example of the newly developed system of special-crop farming.

THE PIEDMONT PLAIN AND THE CONNECTICUT VALLEY LOWLAND.

A small part of the Piedmont Plain extends into the Glacial and Loessial province, including only that section lying between the eastern slope of the Highlands on the west and the Hudson River on the east. It extends south to the boundary of the province and northward to a point where the Highlands reach the west bank of the Hudson River.

Topographically the area is a rolling plain with poorly defined and undeveloped valleys. It can hardly be said to be dissected, the irregularities of surface feature being mainly due to the deposition of the drift rather than to subsequent erosion. Several long, curving ridges rise from 100 to 500 feet above the level of the plain; of these the Palisade ridge along the Hudson River is the most easterly, the others lying west of the midline of the belt and known as the Watchung ridges.

This area, not including the ridges, is underlain by a series of red sandstones and shales of Triassic age. The overlying material consists of a mantle of glacial drift derived in part from the sandstones and shales and in part transported from the Highlands to the north. As a rule there is enough Triassic material in the drift mantle to tinge it with red, especially a foot or so below the surface. The trap ridges are narrow and too steep to cultivate.

The soils are mainly those of the Wethersfield group—a series of general farming soils. On account of the proximity to New York City and the development of suburban villages only a small part of the area is at present devoted to agriculture, much of which is merely suburban gardening and small-fruit growing, with more or less dairying.

THE CONNECTICUT VALLEY LOWLAND.

This division consists of a narrow belt of hilly lowland extending across the southern New England Plateau from north to south and followed in part of its course by the Connecticut River. Topographically it is essentially the same as the Piedmont area of New York and New Jersey, though as a whole it is some-

what rougher and contains a larger area of glacial outwash plains. It is a rolling to hilly area, with rounded hills and open basin-like valleys, except those of the large streams, which are flat-bottomed, steep-sided troughs. It also contains a number of ridges corresponding in character of rock and structural relations with the Watchung ridges in New York and New Jersey, though higher, broader, and more rugged than the latter. They likewise are mainly nonagricultural.

The predominant upland soils, aside from the glacial outwash soils, which are made up mainly of foreign material, are Wethersfield and Holyoke. The glacial outwash soils are represented mainly by the Carver series. This region is much more important agriculturally than the Piedmont area. Although the large cities of Connecticut and some of those in Massachusetts lie in it, they do not dominate the area, except that they supply a market for much of the crops grown on it.

As a whole the region is devoted to general farming, with special attention paid to the growth of high-grade tobacco and to truck and small-fruit crops in certain areas. It is the most important region for the growth of Sumatra tobacco found anywhere in the Northern States. The better soils of the area are in a high state of cultivation and the farmers are prosperous.

THE ATLANTIC COASTAL AREA.

The Atlantic Coastal area includes Cape Cod, Nantucket, Marthas Vineyard, Block Island, Long Island, and Staten Island.

The topography of Cape Cod is that of a typical morainic region, with fringes of lower sand plains accumulated at various points around the borders of the higher land. It consists of irregularly placed low hills with intervening depressions, many of the latter being without outlet. Nantucket, Block Island, and Marthas Vineyard are very much the same in topography as Cape Cod. They consist of a moraine area with typical morainic topography, flanked on the south by broad, smooth outwash plains. Long Island and Staten Island topographically constitute a unit and consist of a rough moraine country, with a southern fringe of smooth outwash plain flanked by long, narrow sand bars along the coast.

The soil material over all of this coastal region is characteristically sandy till, with still more sandy outwash plains, sea beaches, and a considerable development of dune sand. The agriculture on Cape Cod, like that of a portion of the Massachusetts mainland, consists mainly of the growing of cranberries in the bogs formed in the depressions and the production of vegetables for the summer hotel trade. Nantucket, Marthas Vineyard, and Block Island are much less important agriculturally than Cape Cod, and while opportunities exist in some places for the growth of cranberries, the industry has never been developed to any marked extent. The soils are utilized principally for the growing of vegetables and more or less hay. On Long Island a varied system of agriculture prevails, though for the most part the soils are light in texture, often excessively stony, and none of them highly productive, except under intensive methods of farming and high fertilization. The most valuable products are truck and fruit.

CLIMATE.

The area embraced in the Glacial and Loessial province has a range of 46° in longitude and 12° of latitude, with a consequent wide variation in climatic conditions within its borders. The differences in mean temperature, rainfall, and wind movement are wide and exert a marked influence on the character of the agricultural products which can be grown in the geographical extremes of the province. With a growing season of approximately 170 days and a summer mean temperature of 65° the crops which can be grown in northern Maine are naturally considerably restricted, so that corn, which is one of the great staple crops of that portion of the United States covered by this province, can not be grown for the grain. The winters are also too cold for any but the most hardy kinds of fruit trees, such as the Fameuse and Dutchess apples. The absolute minimum temperatures in North Dakota and Montana are 20° lower than in Maine, and the mean precipitation declines from 42.6 inches at Orono, Me., to 19.8 inches at Jamestown, N. Dak. The crops which can be grown are limited to a great extent by the length of the growing season and the mean of the summer temperature, but depends no less upon precipitation and the ability

of the soil to retain moisture. In the western part of the province the precipitation is not only less, but evaporation is greater, owing to the lack of a protecting forest cover, which in the North Central and New England States checks to a large extent the movement of wind.

In the North Central and Lake States there is a range in absolute minimum temperature, north and south, of 26° as between —16° at Cairo, Ill., and —42° at Mount Iron, in St. Louis County, Minn. The difference in annual mean temperature, however, is 21°, as represented by 58° at Cairo and 37° at Mount Iron. This naturally allows a considerable latitude in the agricultural products, Cairo reaching down to the northernmost latitudes of cotton production, while Mount Iron is considerably beyond the latitude where corn and winter wheat can safely be grown. The growing period at the southern extremity of this region is approximately 200 days, while in the northern part it is only about 140 days. The shortest growing period in the area covered by this province is about 125 days in the northern part of North Dakota. At Topeka, Kans., it is about 180 days; at Columbus, Ohio, 180 days; at Auburn, N. Y., about 160 days; at Orono, Me., 135 days; at Portland, Me., 187 days; and at New York City, 210 days.

Differences in altitude exert a marked influence on temperature and the growing period for crops, those which can be grown in such elevated regions as the Allegheny Plateau in southern New York and northern Pennsylvania being fewer in kind than on the Ontario low belt above the lake ridges or on the uplands of the Mohawk Valley. The average length of the growing season at Angelica, on the plateau, in Allegany County, southern New York, at an elevation of 1,470 feet, is 125 days, while at Avon, 50 miles north of that point, at an elevation of 585 feet, it is 141 days. Only the hardier, earlier maturing varieties of corn can be successfully grown at such altitudes, the farm crops being confined more to late potatoes, buckwheat, and hay.

The variation in precipitation over the region is greatest between the eastern and western extremes, as before indicated, the average annual precipitation in the New England States being between 40 and 50 inches for the whole region, and well distributed throughout the year, the winter precipitation including from 60 to nearly 100 inches of snow. The rainfall in New York ranges from 30 inches in the St. Lawrence River Valley to 48 inches on Long Island. The average annual precipitation for Ohio is about 38 inches, with no great variation in different sections of the State. The rainfall in Michigan averages about 33 inches for the State as a whole, being greatest along Lake Michigan and the southern tier of counties. West of Lake Michigan and Lake Superior the rainfall gradually diminishes, ranging from 30 inches at Manitowoc, Wis., to 24 inches at Morehead, Minn., and 16 at Williston, N. Dak. The snowfall in the central and western section is heaviest in the region of the Great Lakes and, with the exception of the eastern slope of the Rocky Mountains in Montana, least on the Dakota plains.

In this soil province 30,454,572 acres have been covered by detailed survey and mapped on a scale of a mile to the inch, and 20,502,848 acres on a reconnoissance scale of 4 to 6 miles to the inch, with an overlap of 1,961,856 acres, making a net total of 48,995,564 acres. Of this area, 47,069,676 acres represent mainly agricultural soils, with 1,925,888 acres of miscellaneous material, the most of which is nonagricultural land. Of the agricultural lands, 28,655,980 acres have been classified into soil types and 18,413,696 acres have been classified as to material or series, but not as to actual soil types.

DESCRIPTION OF THE SOIL SERIES.

Adirondack series.—The Adirondack soils are brown to yellow, with subsoils of the same color but of a lighter shade. The structure and texture are essentially the same and the soil inclined to be droughty. The topography is hilly to mountainous.

The material is morainic, colluvial and local wash derived by glaciation of crystalline and metamorphic Adirondack rocks, and other rocks to the northward.

Area and distribution of the soil of the Adirondack series.

Soil name.	State or area.[1]	Acres.
Adirondack stony sandy loam	New York 16, 17; Vermont 1	59,456

[1] For key to numbers in this column see p. 733.

Bangor series.—The Bangor series is characterized by grayish to yellowish-brown surface soils, with subsoils of lighter gray and yellowish-brown. All of the types are stony and gravelly. The soils are derived from glacial till containing more or less material from the local serecitic schist rock. The topography is rolling to hilly. With the exception of the stony loam and shallow phase of the loam, the types of this series are fair general farming soils.

Area and distribution of the soils of the Bangor series.

Soil name.	State or area.[1]	Acres.
Bangor sandy loam	Maine 2	37,184
loam	do	32,576
stony loam	do	29,248
Total		99,008

[1] For key to number in this column see p. 733.

Bernardston series.—The soils of this series are dark in color. The upper subsoils are dark yellow and grade into slaty blue. The structure becomes very compact with depth and heavier in the lower subsoil. The topography is broken to hilly and the surface is good. The cultivated areas occur in drumloidal hills. The soils are of glacial origin, the underlying consolidated rocks being argillaceous and frequently exposed in outcrops. The loam member of the series, the only type so far mapped, is a good soil for grass, corn, oats, and rye.

Area and distribution of the soil of the Bernardston series.

Soil name.	State or area.[1]	Acres.
Bernardston loam	Massachusetts 1	16,064

[1] For key to number in this column see p. 733.

Caribou series.—The members of this series have yellowish-brown soils which usually rest upon a light-gray lower till. The soil material is derived from glacial till overlying calcareous shales or shaly limestone, the till derived largely from the underlying calcareous formation, the material having been transported for a comparatively short distance. Fragments of the underlying formation are distributed throughout both soil and subsoil of all the types. The underlying rock is frequently encountered within 3 feet of the surface. Except in a few stony areas, the soils are very productive, being especially adapted to Irish potatoes, grain, and peas.

Area and distribution of the soils of the Caribou series.

Soil name.	State or area.[1]	Acres.
Caribou loam	Maine 1	220,672
stony loam	do	3,328
gravelly loam	do	3,904
silt loam	do	10,176
Total		238,080

[1] For key to number in this column see p. 733.

Carrington series.—The Carrington soils are derived through weathering of the glacial till, with little or no modification from loessial deposits. The series is developed in the Central and Western Prairie region and consists mainly of prairie soils. The soils are generally black in color, ranging in some cases to dark brown. The subsoils are lighter colored, generally having light brown or yellowish color. The topography is gently undulating to rolling, though in some instances nearly flat areas are found. The series consists principally of loams, silt loams, and clay loams, and is chiefly made up of what was formerly called Marshall loam, silt loam, and clay loam. Corn and wheat are the principal crops grown.

Area and distribution of the soils of the Carrington series.

Soil name.	State or area.[1]	Acres.
Carrington gravel	Minnesota 4; North Dakota 1	2,560
sandy loam	Illinois 11; Kansas 2; Minnesota 5; North Dakota 3; South Dakota 2.	208,384
gravelly sandy loam.	North Dakota 9	10,048
fine sandy loam	Indiana 7; Minnesota 1; North Dakota 8; Wisconsin 3	69,184
loam	Indiana 6, 7; Iowa 1, 3, 4; Michigan 3; Minnesota 1, 4, 5; Nebraska 3; North Dakota 1, 2, 5, 9; Wisconsin 3, 12, 15.	1,616,768
stony loam	North Dakota 2, 5, 8; South Dakota 2	84,096
gravelly loam	Kansas 2; Minnesota 4; North Dakota 2, 4, 8; Wisconsin 4	81,984
silt loam	Indiana 10; Minnesota 1, 5; North Dakota 2, 5; South Dakota 2; Wisconsin 3, 4, 6.	856,640
clay loam	Iowa 1, 3; Minnesota 1, 5; North Dakota 8; Wisconsin 12, 15	613,120
black clay loam	Indiana 1, 4, 5, 6, 7; Iowa 1; Michigan 6, 7; North Dakota 5; Ohio 2, 4, 7, 9.	210,512
Total		3,753,296

[1] For key to numbers in this column see p. 733.

Carroll series.—The soils of this series are characterized by their gray color and by the darker color and compact, impervious structure of the subsoils. Iron concretions are often found in abundance, especially in the subsoil. These soils occupy flat areas where they are associated with the Richland silt loam. They are predominantly silty in character, being derived principally from loessial material. Owing to their flat surface, drainage is poorly established. The organic-matter content is low and consequently they have not been extensively used for agriculture. With proper drainage they should give good results with corn, sugar cane, Irish potatoes, cabbage, and cotton. Rice should also do well.

Area and distribution of the soil of the Carroll series.

Soil name.	State or area.[1]	Acres.
Carroll silt loam	Louisiana 6	83,584

[1] For key to number in this column see p. 733.

Cazenovia series.—The Cazenovia soils are brown in color, with brown to reddish subsoils resting upon limestone at a depth of about 3 feet. Fragments of limestone and red sandstone are found throughout the soil, and occasionally large bowlders are scattered over the surface. The topography is rolling to level, the areas occupying high rolling hills and table-lands. These soils are derived from glacial till containing considerable limestone material. The principal crops are grass, alfalfa, corn, wheat, and potatoes.

Area and distribution of the soil of the Cazenovia series.

Soil name.	State or area.[1]	Acres.
Cazenovia loam	New York 9, 14	176,512

[1] For key to numbers in this column see p. 733.

Coloma series.—The soils of this series are light brown to grayish in color, with yellow to reddish subsoils. They are usually leachy and inclined to be droughty, producing light yields of farm crops. The topography is generally rolling to rough and hilly, representing terminal and ground moraines. The residual material is essentially sandy and gravelly, only a limited amount of the finer textured members occurring in the series. These soils are found typically developed in northern Michigan, Wisconsin, and Minnesota. They once supported extensive pine forests. The series is formed from relatively coarse glacial material, modified to some extent by the action of wind and water.

Area and distribution of the soils of the Coloma series.

Soil name.	State or area.[1]	Acres.
Coloma sand	Indiana 6; Michigan 1, 2, 3, 4, 7, 8, 10; Minnesota 2; Ohio 10; Wisconsin 11, 13, 16.	1,178,568
gravel	Wisconsin 12	6,080
stony sand	Michigan 1, 7; Wisconsin 11, 16	26,166
gravelly sand	Michigan 1, 6, 7; Wisconsin 1, 16	34,890
fine sand	Illinois 11; Michigan 1, 3, 6; Minnesota 2; Wisconsin 3, 10	247,820
sandy loam	Michigan 1, 3, 4, 6, 7; Minnesota 2; Wisconsin 6, 11, 13, 16	538,228
gravelly sandy loam	Indiana 6, 10; Michigan 2, 3, 6, 7; Minnesota 2	40,768
fine sandy loam	Michigan 3; Wisconsin 3, 10	171,648
loam	Wisconsin 10, 16	61,056
Total		2,305,224

[1] For key to numbers in this column see p. 733.

Cossayuna series.—The Cossayuna soils are brown or snuff-colored, with subsoils of the same color but of a lighter shade. Both soil and subsoil contain considerable quantities of shale and calcareous sandstone fragments, with a small percentage of foreign bowlders. The soils are derived from glacial till, largely influenced by the underlying calciferous sandstone or arenaceous limestone. The soil mantle is usually more than 3 feet thick, though in many places rock occurs near the surface. The soils occupy rolling to hilly uplands. The principal crops are corn, oats, hay, potatoes, apples, and other tree fruits.

Area and distribution of the soils of the Cossayuna series.

Soil name.	State or area.[1]	Acres.
Cossayuna stony loam	New York 17	88,448
fine sandy loam	Michigan 4; New York 5	24,896
Total		113,344

[1] For key to numbers in this column see p. 733.

Culvers series.—The soils of this series are predominantly brown or grayish-brown, with yellowish-brown subsoils of a peculiar reddish cast. The greater part of the material of this series is derived from the intermixing under glacial action of the Medina sandstone and Shawangunk conglomerate of Kittatinny Mountain, the material having been swept from its original position and deposited in the Kittatinny Valley, overlying the Hudson River shales. The

latter formation, however, seems to have but little influence upon the soil, the till material being for the most part very thick and comparatively free from shale. The topography is rolling to slightly hilly.

Area and distribution of the soils of the Culvers series.

Soil name.	State or area.[1]	Acres.
Culvers loam	New Jersey 2	3,328
stony loam	do	23,360
Total		26,688

[1] For key to number in this column see p. 733.

Dover series.—The Dover soils are light-brown, brown, or dark-brown to reddish in color, with light brown, yellowish, or reddish subsoils. Both soil and subsoil have essentially the same structure and texture. Fragments of limestone often occur scattered through both soil and subsoil. Drainage is good. The series occurs in the limestone lowland belts of the Appalachian region and is derived from glacial till, the material being considerably influenced by the inclusion of local limestone material. The topography is undulating to strongly rolling, with abundant outcrops of limestone ribs, knobs, and low hills. The members of this series are strong general farming soils.

Area and distribution of the soils of the Dover series.

Soil name.	State or area.[1]	Acres.
Dover stony sandy loam	New York 17	5,056
fine sandy loam	New Jersey 2; New York 4	9,024
loam	do	50,112
stony loam	New Jersey 2	21,632
Total		85,824

[1] For key to numbers in this column see p. 733.

Dutchess series.—The Dutchess soils are brown to light brown, with bluish, light-brown, yellowish, or reddish-yellow subsoils. The soils are friable, the subsoils being somewhat heavier in texture than the soil. Some of the types are underlain by a bluish-gray substratum, while others rest upon the country rock. In some types rounded and angular gravel occur in both soil and subsoil, rarely the fragments being limestone. The topography is rolling to undulating and rough, much of the relief consisting of rounded drumloidal hills. The drainage of the heavier types is only fair. The soil material is glacial and derived mainly from the Hudson River shales and slates. The series is adapted to oats, grass, potatoes, and tree fruits. Corn and wheat do not do well.

Area and distribution of the soils of the Dutchess series.

Soil name.	State or area.[1]	Acres.
Dutchess loam	New Jersey 2; New York 5	51,776
stony loam	New Jersey 2; New York 4, 17	130,048
shale loam	New Jersey 2	54,272
slate loam	New York 4, 17	138,624
silt loam	do	129,984
silty clay loam	New York 5	13,120
Total		517,824

[1] For key to numbers in this column see p. 733.

Easton series.—The Easton soils are ashy gray to nearly white in color. The subsoils are mottled gray to yellow, the latter color becoming more prominent with depth, at 36 inches only a slight gray mottling being noticeable. Frequently a layer of sticky clay occurs at 20 to 30 inches. Both soil and subsoil carry glacial bowlders and considerable gravel of sandstone and shale. The series is of glacial origin. The soils occupy depressed areas associated with Caribou loam and in strips bordering Muck.

Drainage as a rule is poorly established. Oats and grass do fairly well, although the latter crop is often winter killed.

Area and distribution of the soil of the Easton series.

Soil name.	State or area.[1]	Acres.
Easton loam	Maine 1	9,024

[1] For key to number in this column see p. 733.

Farmington series.—The Farmington soils are light brown in color and of slight depth, the soil layer often resting directly upon the shaly limestone which forms bedrock. Angular fragments of limestone and a small percentage of glacial gravel and stones are found throughout the soil mass. The topography is level, and drainage is usually good. The soil is partly residual and partly glacial. It is adapted to corn, oats, clover, beans, and potatoes.

Area and distribution of the soils of the Farmington series.

Soil name.	State or area.[1]	Acres.
Farmington loam	New York 11, 13	10,560
silt loam	New York 5	25,856
Total		36,416

[1] For key to numbers in this column see p. 733.

Flushing series.—The soils are brown in color and overlie yellowish or reddish subsoils, sometimes micaceous, and in some instances resting on crystalline rocks. Only one member of this series has thus far been encountered—the old Miami stony loam of the Long Island, New York, and Rhode Island areas. The material is a till deposit associated with the retreat of the glacier from the terminal moraine which gave rise to the Plymouth and Carver soils.

Area and distribution of the soil of the Flushing series.

Soil name.	State or area.[1]	Acres.
Flushing loam	New York 7; Rhode Island 1	201,984

[1] For key to numbers in this column see p. 733.

Gloucester series.—The soils of the Gloucester series are light brownish or often grayish at the immediate surface and overlie yellow subsoils. In many areas the presence of a small amount of mica in the soil and subsoil is a common characteristic, though this need not necessarily be present. The soils are derived from a rather local glaciation of crystalline rocks consisting chiefly of granite and gneiss, together with a less amount of schist, the material being left as a rather thin mantle of ground moraine. Scattered rocks and bowlders of large size occasionally occur, rendering the use of farm machinery difficult. The topography ranges from gently undulating to rolling or hilly, the hills often being quite high, broad, and smoothly rounded. The drainage of these soils is usually fair to good, and in many places excessive. In the original forest growth white pine was well represented, together with some maple,

elm, and oak, the cut-over areas being now succeeded by a second growth in which birch is common. Areas where the topography is favorable for agriculture and the stones not too numerous produce fair yields of corn, potatoes, oats, hay, and considerable fruit, especially apples.

Area and distribution of the soils of the Gloucester series.

Soil name.	State or area.[1]	Acres.
Gloucester sandy loam	Massachusetts 2; New Jersey 2	56,320
stony sandy loam	Massachusetts 2; New Hampshire 1, 2; New Jersey 2.	112,640
fine sandy loam	Connecticut 2	93,440
stony fine sandy loam	do	93,952
loam	Connecticut 2; Massachusetts 2; New Jersey 2; New York 4.	122,368
stony loam	Massachusetts 2; New Hampshire 1, 2; New Jersey 2; New York 4.	141,632
Total		620,352

[1] For key to numbers in this column see p. 733.

Hamburg series.—The Hamburg soils are grayish yellow to light brown in color. The subsoil is of the same color, though mottled in places, and contains lime and iron pipes and concretions. The surface material is loose and floury and subject to more or less reworking by wind, but the undisturbed subsoil and substratum are somewhat compact and the material in many places stands in vertical cliffs. The soil is excessively drained on account of its rough topography. It is a river-bluff soil found in the Middle West and derived from loess. It has very little agricultural value.

Area and distribution of the soil of the Hamburg series.

Soil name.	State or area.[1]	Acres.
Hamburg silt loam	Missouri 1	3,008

[1] For key to number in this column see p. 733.

Hollis series.—These soils are light brown in color, with grayish to light yellow subsoils, in some types slightly heavier than the soil. Slaty fragments of schistose rock and considerable mica are often found throughout the soil section. The material is derived in part from glacial till and in part from the underlying micaceous schistose rock. The topography consists of low knolls and ridges, though in places the local relief ranges up to 200 feet.

Area and distribution of the soil of the Hollis series.

Soil name.	State or area.[1]	Acres.
Hollis stony loam	New Hampshire 2	7,040

[1] For key to number in this column see p. 733.

Holyoke series.—The soils are brown to dark yellow in color. The subsoils are yellow and somewhat heavier than the soil. The topography is rough and outcrops of the parent rock are abundant. The material is glacial in origin and is derived from a variety of metamorphic, diabase, and crystalline rocks, the thickness of the layer of soil material varying up to 100 feet. These soils are moderately productive.

Area and distribution of the soil of the Holyoke series.

Soil name.	State or area.[1]	Acres.
Holyoke stony loam	Connecticut 1; Massachusetts 1	196,818

[1] For key to numbers in this column see p. 733.

Judson series.—The Judson series comprises the soils in the Glacial and Loessial region which have been formed principally through colluvial action. The soils range from a brown to a dark brown and almost black in color, and are usually deeper than the soils upon the upland. They are found at the foot of bluffs or rather steep slopes between the upland and the bottoms. They are not subject to overflow, and at present suffer but little from erosion. On account of the considerable amounts of organic matter incorporated into these colluvial soils in the process of their formation they are exceedingly valuable for the production of general farm crops. In Blue Earth County, Minn., they are formed through the wash from glacial drift, while in some of the more southern areas in the loessial belt the soils are due to the colluvial action from the loess, modified slightly by a mixture of the underlying glacial till or residual material from rock exposures occurring in the higher-lying bluffs.

Area and distribution of the soils of the Judson series.

Soil name.	State or area.[1]	Acres.
Judson fine sandy loam	Missouri 12	4,096
gravel	Illinois 10, 11; Wisconsin 6	15,296
loam	Minnesota 1; Missouri 12	17,152
silt loam	Missouri 1, 4	10,688
Total		47,232

[1] For key to numbers in this column see p. 733.

Kewaunee series.—This series is developed most extensively in the region of Lakes Michigan and Superior, and is characterized by grayish to reddish-brown or pinkish soils overlying pinkish-red silty clay and rather calcareous subsoils. Like other soils derived from till, the 3-foot section contains more or less subangular gravel, stones, and bowlders. The material is essentially like that of the Superior series, and the greater proportion of it was originally laid down as glacial-lake deposits, but has been plowed up by subsequent glacier action and mixed with more or less stony material, so that it now has the character and appearance of glacial till. The topography varies from undulating ground moraine to hilly terminal moraine, and is subjected to more or less erosion. The soils of this series are most extensively represented by the heavier members, which as a rule are deficient in underdrainage. With proper drainage their agricultural value will be found equal or superior to that of the corresponding members of the Miami series.

Area and distribution of the soils of the Kewaunee series.

Soil name.	State or area.[1]	Acres.
Kewaunee fine sandy loam	Wisconsin 8	2,112
loam	Minnesota 2; Wisconsin 8	33,408
stony loam	Minnesota 2	8,704
clay loam	Wisconsin 4, 8	121,216
gravelly loam	Wisconsin 4	1,280
Total		166,720

[1] For key to numbers in this column see p. 733.

Knox series.—The soils of this series occur principally in the Central Prairie States, and represent the light-brown soils derived from loessial or other wind-

blown deposits. The larger body of the soil material is made up of what was formerly called Miami silt loam, where this type was derived directly from the loess. The loessial covering in this series is always thick enough to form the subsoil as well as the surface soil, the deeper-lying glacial till being far enough from the surface to have no marked influence on the general character of the soil. The topography is gently undulating to rolling and the surface is generally well drained. Grain crops constitute the chief agricultural interests.

Area and distribution of the soils of the Knox series.

Soil name.	State or area.[1]	Acres.
Knox sand	Indiana 3, 8	8,192
fine sand	Illinois 8, 10; Indiana 10; Iowa 4; Nebraska 6; Wisconsin 9	93,888
sandy loam	Indiana 3; Iowa 2	25,984
fine sandy loam	Indiana 10	4,608
silt loam	Illinois 3, 5, 6, 7, 8, 10, 11; Indiana 2, 3, 8, 10; Iowa 2, 4; Kentucky 6; Missouri 4, 6, 8, 10, 13, 14, 16, 18; Nebraska 5; Wisconsin 3, 5, 7, 9, 14.	2,576,832
Total		2,709,504

[1] For key to numbers in this column see p. 733.

Lackawanna series.—These soils are derived from glacial drift that occurs as a relatively thin mantle overlying the red shales and limestones, usually of the Catskill and Medina formations, in Pennsylvania and New Jersey. The till, which has a peculiar Indian-red color, is derived from these rocks, and contains a variable amount of loose gravel, stones, and bowlders. Very little material of foreign origin is included in the soil material of this series. The topography is, for the most part, rolling to hilly and mountainous, with occasional flat-topped, plateau-like areas. Drainage is good, except in the more level positions, where some artificial drainage is often desirable. Where the topography permits and where the soils are not too stony the agricultural value is about the same as or better than in the case of the Volusia soils, which the Lackawanna soils resemble in respects other than that of color.

Area and distribution of the soils of the Lackawanna series.

Soil name.	State or area.[1]	Acres.
Lackawanna loam	New Jersey 2	12,928
stony loam	do	18,624
silt loam	Pennsylvania 4	115,200
silty clay loam	do	4,736
undifferentiated	Pennsylvania 13	481,152
Total		632,640

[1] For key to numbers in this column see p. 733.

Lexington series.—The Lexington soils are gray to yellowish gray in color and mellow in structure. The subsoil is yellow to brown, with a tinge of red in places, and is often somewhat heavier than the soil. Drainage is good and the topography moderately rolling to hilly. The types are derived from loess, the material closely resembling that of the Memphis soils, but the layer of loess is thin, the underlying reddish material known as the Orange sand formation modifying the soil in places. These soils are adapted to corn, cotton, forage crops, vegetables, and strawberries.

Area and distribution of the soil of the Lexington series.

Soil name.	State or area.[1]	Acres.
Lexington silt loam	Tennessee 6, 8	342,272

[1] For key to numbers in this column see p. 733.

Mapleton series.—The Mapleton soils are purplish red in color. The subsoil, where such exists, is reddish yellow. Usually a conglomerate bedrock lies from 6 to 20 inches beneath the surface. Where stone or gravel occurs in either soil or subsoil it is both water-worn and angular and of sandstone or quartz. The topography consists of ridges and slopes. The soils are adapted to potatoes, grass, and grain. Apples do fairly well.

Area and distribution of the soil of the Mapleton series.

Soil name.	State or area.[1]	Acres.
Mapleton gravelly loam	Maine 1	192

[1] For key to number in this column see p. 733.

Marion series.—These soils are gray, white, or ash colored. The subsoils are white at top, the white layer varying in thickness from 2 to 12 inches and averaging about 5 inches. This layer is a compact, impervious whitish silt or very fine sand; often containing iron concretions, and locally known as hardpan. Beneath this the true subsoil is a gray, light-yellow to reddish-yellow or mottled brownish-yellow, hard, impervious clay containing occasional concretions of iron and of lime. The topography is gently undulating to hilly where badly eroded. The drainage is not good. The material is of doubtful origin, being either water laid, glacial, or loessial where it overlies gravelly till or residual soil from Coal Measure shales and clays.

Area and distribution of the soil of the Marion series.

Soil name.	State or area.[1]	Acres.
Marion silt loam	Illinois 1, 2, 9; Missouri 14	695,040

[1] For key to numbers in this column see p. 733.

Marshall series.—The Marshall series includes the dark-colored upland loessial soils, which predominate in the great prairie region of the Central West. The soils of this series are characterized and distinguished from those of the Knox series by the greater quantity of organic matter in the surface soils, which give them a dark-brown to black color. The topography is level to rolling, and artificial drainage is usually necessary to secure the best results. They are very productive and constitute the great corn soils of the country.

Area and distribution of the soils of the Marshall series.

Soil name.	State or area.[1]	Acres.
Marshall fine sand	Iowa 3; Minnesota 1; North Dakota 2	23,040
sandy loam	Minnesota 4	3,008
fine sandy loam	Indiana 10; North Dakota 2	33,280
loam	Illinois 6; Minnesota 5	22,976
silt loam	Illinois 2, 5, 6, 8, 9, 11; Indiana 3, 10; Iowa 4; Kansas 2, 7; Louisiana 7; Missouri 1, 6, 10, 13, 16, 18; Nebraska 3, 5, 6; Wisconsin 5, 14.	3,480,902
black-clay loam	Illinois 5, 6, 8, 10; Indiana 10	228,224
Total		3,791,430

[1] For key to numbers in this column see p. 733.

Memphis series.—The Memphis series is characterized by the light-brown to yellowish-brown color and silty texture of the surface soils and by the slightly lighter color and more compact structure of the subsoils. These soils are typicaly developed to the south of the latitude of St. Louis, being most extensive in the loessial belt following the east bank of the Mississippi River. Drainage

is ordinarily well established. Erosion has been active and has resulted in a prevailingly rolling to broken topography. A characteristic of the soil of this series is the tendency of the material to stand in perpendicular bluffs or sections. The series is well suited to corn, oats, peanuts, forage crops, Irish potatoes, cabbage, and a number of vegetables. Cotton also does well.

Area and distribution of the soil of the Memphis series.

Soil name.	State or area.[1]	Acres.
Memphis silt loam	Illinois 4, 7, 9; Kentucky 1; Louisiana 7, 10; Mississippi 1, 4, 6, 7, 13, 19, 21; Missouri 14; Tennessee 8.	2,035,642

[1] For key to numbers in this column see p. 733.

Miami series.—The Miami series is one of the most important of the province. The soils are brown, light brown, or grayish, and are underlain by yellowish and brown heavier textured subsoils. Mottlings of brown and light gray are present in the subsoils in many places, particularly in the case of the clay loam member, which is by far the most extensive type mapped. The surface drainage is usually good, but artificial drainage is necessary in some of the heavier types. The soils are in the main derived, through weathering, from glacial till of a generally calcareous nature. Some of the gravelly phases, however, are, in part at least, water assorted, having been deposited as obscurely stratified material in the form of kames, eskers, etc. The series represents considerable range in texture and its members are adapted to a wide variety of both general field crops and special truck and fruit crops. Dairying is an important industry on the heavier types.

Area and distribution of the soils of the Miami series.

Soil name.	State or area.[1]	Acres.
Miami sand	Wisconsin 15	1,920
fine sand	Wisconsin 3	43,584
gravel	Wisconsin 15	20,672
sandy loam	Wisconsin 4	1,280
gravelly sandy loam	Wisconsin 15	51,520
fine sandy loam	Michigan 2, 5, 6, 7, 8; Wisconsin 3, 10, 15	388,160
loam	Michigan 1, 3; Minnesota 2; Ohio 3, 10; Wisconsin 3, 8, 11, 12, 15.	432,886
gravelly loam	Ohio 2; Wisconsin 4	45,376
silt loam	Illinois 2; Indiana 10; Wisconsin 3, 4, 6, 15	455,104
clay loam	Indiana 1, 4, 5, 6; Iowa 3; Michigan 1, 2, 5, 6, 7, 8; Ohio 2, 3, 4, 7, 9, 10; Wisconsin 12, 15.	2,312,330
Total		3,752,832

[1] For key to numbers in this column see p. 733.

Mohawk series.—The Mohawk soils usually consist of dark-colored glacial material derived in part from dark-colored calcareous shales and limestones, but modified to a varying degree by admixture of glacial material from other formations. The series is characterized by the presence of the partly weathered fragments of calcareous shale and of limestone, by its usual dark color, and by its more or less intimate association with the soils of the Palatine series. The topography is rolling to hilly and the natural surface drainage good. The soils vary in productivity, but are considered good general farming soils. The series will probably be of local occurrence where glaciation has intermingled materials from the black shales and limestones with other glacial material throughout eastern New York.

Area and distribution of the soils of the Mohawk series.

Soil name.	State or area.[1]	Acres.
Mohawk loam	New York 11	7,680
silt loam	do	45,440
clay loam	do	67,200
Total		120,320

[1] For key to numbers in this column see p. 733.

Nunda series.—The Nunda soils are light brown in color, with brown to bluish or slate-colored subsoils. Both soil and subsoil contain considerable rounded glacial stones, many of which are limestone. The soil material is derived from till (moraine). Only one type, the stony loam, of inextensive area, has been so far separated and mapped.

Area and distribution of the soil of the Nunda series.

Soil name.	State or area.[1]	Acres.
Nunda stony loam	New York 6	320

[1] For key to number in this column see p. 733.

Ontario series.—The soils of this series are brown to chocolate-brown in color, the subsoils being lighter, and in many cases grading into yellow. Both soil and subsoil usually contain scattered fragments of limestone. They are derived from the weathering of the glacial till of the drumlin region of New York. The topography is undulating to moderately hilly, depending upon the number and shape of the drumlins within a given area. Some of the areas intervening between the drumloidal hills are rather flat. The series includes all soils of this color and character, whether the topography is that of typical drumlins or not. The most important features are the color and calcareous nature of the soil, the thickness of the glacial deposits, and the undulating to rolling topography.

Area and distribution of the soils of the Ontario series.

Soil name.	State or area.[1]	Acres.
Ontario gravelly sandy loam	New York 10, 13	6,080
fine sandy loam	New York 5, 10, 13	157,696
loam	New York 1, 8, 10, 13, 15	446,016
stony loam	New York 5, 14	3,904
gravelly loam	New York 13	4,992
silt loam	New York 10	18,688
Total		637,376

[1] For key to numbers in this column see p. 733.

Plymouth series.—The soils included in the Plymouth series are composed principally of glacial material coming largely from granites, although other rocks may be represented to a less extent. The series includes the morainal and till deposits found in southeastern New England and on Long Island, together with the smaller coastal islands of this group of States. It is essentially the last great terminal moraine, which consists of a stony, gravelly, and sandy till. As a result the soils of the series fall naturally into the stony sand, stony sandy loam, gravelly sandy loam, sandy loam, and possibly loam types. The surface soils are shallow and brown, underlain by a pale yellow subsoil. In some locations the compact gray till is found within the soil section, particularly in the morainal belt. The altitudes attained by the soils of this series never exceed 350 feet above sea level. The material of moraine and till, except on Long Island, rests upon the complex granites and gneisses of southeastern New England, constituting deposits from a few feet to 150 feet in thickness.

Area and distribution of the soils of the Plymouth series.

Soil name.	State or area.[1]	Acres.
Plymouth stony sand	New York 7	5,376
sandy loam	New York 7; Rhode Island 1	170,560
stony sandy loam	Massachusetts 2	19,520
Total		195,456

[1] For key to numbers in this column see p. 733.

Portage series.—The Portage soils are gray to grayish-brown, with gray, yellowish-brown, brownish-yellow, or yellow subsoils resting upon a red clay substratum. In the lighter types fragments of granite are of common occurrence and the soils and subsoils are about the same in texture. In the medium heavy types the subsoils are slightly heavier. The material is derived mainly from glacial till, the substratum and a part of the subsoil being probably of residual granitic origin. The surface of the medium heavy types is possibly in part loessial. The topography is level to gently rolling, and drainage is good except on the level areas.

Area and distribution of the soils of the Portage series.

Soil name.	State or area.[1]	Acres.
Portage sandy loam	Wisconsin 11	9,792
stony sandy loam	do	11,392
silt loam	do	22,656
Total		43,840

[1] For key to numbers in this column see page 733.

Putnam series.—This series includes dark gray to black soils overlying impervious drab or brown subsoils of fine texture and close structure. One of its principal characteristics is the presence of a whitish silty layer between the soil and the subsoil. The soils occupy level to gently undulating upland prairies, and are derived from loessial deposits. On account of the rather level surface and the dense "hardpan" structure of the subsoil, drainage is seldom adequate. The Putnam soils differ from the true Shelby soils in containing little or none of the glacial till, though this usually underlies the Putnam at variable depths. Consequently few occurrences of soils coarser than silt loams will be found in this series. The series was established to include the soil which had been previously classified as Shelby silt loam, but which differed from the other Shelby soils in being derived entirely from the loess.

Area and distribution of the soil of the Putnam series.

Soil name.	State or area.[1]	Acres.
Putnam silt loam	Missouri 2, 12, 13, 17, 19, 20, 21	1,050,112

[1] For key to numbers in this column see p. 733.

Richland series.—The Richland series is characterized by the light-brown to yellowish-brown color and silty texture of the surface soils and the somewhat lighter color and more compact structure of the subsoils. These soils are derived from loess and occur in association with the Memphis soils. The Richland series represents areas of loessial soils having a smooth, flat to undulating topography, with drainage well established. Corn, cotton, peanuts, oats, forage crops, lespedeza, bur clover, cabbage, and Irish potatoes give very good results.

Area and distribution of the soil of the Richland series.

Soil name.	State or area.[1]	Acres.
Richland silt loam	Louisiana 6; Mississippi 1, 6	164,352

[1] For key to numbers in this column see p. 733.

Rodman series.—The soils of this series vary in color from medium or light grayish brown to yellowish gray, with sometimes a slight reddish cast. The material is assorted to a greater or less extent—always much more than glacial till material—so that the soils are more leachy, unretentive of moisture, and droughty than the soils derived from till. The material may contain sandstone, shale, limestone, or granite, gneiss, and other crystalline rocks. The topography is rolling to hilly or steep and rough, with occasional flat-topped or truncated hills. The material has been formed within or underneath the ice and left as characteristic kames and eskers of the glacial regions. While the material has been assorted, the presence of stratification or cross bedding will in many cases be difficult or impossible of detection for want of sections and because of the indefiniteness of such stratification. The identification of the material under field conditions is based upon the uniformly more gravelly and sandy texture of the soils, in combination with the peculiar kame and esker topography, as contrasted with the ground moraine or terminal moraine of the purely ice-laid till soils. The soils of this series have not been subjected to material modification by glacial-lake waters, though in some cases they may have been covered by them. The kame and esker material which has been subjected to considerable modification will be classed with the Dunkirk or other glacial-like series.

Area and distribution of the soils of the Rodman series.

Soil name.	State or area.[1]	Acres.
Rodman gravel	Wisconsin 4, 8	5,568
stony sand	New York 5	6,784
gravelly sand	Wisconsin 4	640
fine sand	Wisconsin 8	1,024
sandy loam	New York 5; Wisconsin 8	23,936
gravelly sandy loam	Wisconsin 8	1,792
gravelly loam	New York 5; Pennsylvania 4; Wisconsin 8	11,008
Total		50,752

[1] For key to numbers in this column see p. 733.

Safford series.—The Safford soils are gray to light yellow in color, with red or reddish-brown subsoils, the substratum from a depth of 3 feet downward being of greensand. In places the greensand, or a grayish-yellow clay derived from it, approaches more closely the surface. The subsoils are usually heavier than the soil. The topography is rough on account of thorough dissection, and the surface drainage is excessive. Underdrainage is poor. The soil and subsoil above the greensand layer are of loessial origin. The rest of the subsoil and the substratum are derived from the greensand layer.

Area and distribution of the soil of the Safford series.

Soil name.	State or area.[1]	Acres.
Safford silt loam	Tennessee 6	28,544

[1] For key to number in this column see p. 733.

Scottsburg series.—These soils are light ashy gray in color with light-yellow subsoils slightly mottled with yellow and somewhat heavier than the soils. Small iron concretions are found scattered through the soil. The material may be either water-laid, glacial, loessial, or residual from shales. The topography of the watersheds is smooth, becoming rougher as the streams are approached. The drainage is best in the rougher areas, being only fair to poor on the more level land.

Area and distribution of the soil of the Scottsburg series.

Soil name.	State or area.[1]	Acres.
Scottsburg silt loam	Indiana 9	37,184

[1] For key to number in this column see p. 733.

Shelby series.—The soils of this series are yellowish gray or yellowish brown to brown in color, and so far as recognized consist of loams and sandy loams. The subsoils are yellow or reddish-yellow or light-brown tenacious sandy clays noticeably heavier than the surface soils, which to a considerable extent are influenced by remnants of the former loessial covering. The subsoils not infrequently contain iron pipes and nodular masses and streaks of calcareous material. The soils are derived from the Kansas drift and occupy steep stream slopes and narrow divides projecting into areas of the Putnam silt loam. They are subject to considerable erosion. The areas were originally timbered with white and scrub oak, some hickory, red oak, and elm. Not more than one-third of the areas are under cultivation, but where not too steep for farming purposes they produce good yields of oats and grass and fair crops of corn and wheat.

Area and distribution of the soils of the Shelby series.

Soil name.	State or area.[1]	Acres.
Shelby loam	Kansas 9; Missouri 1, 2, 12, 13, 16, 17, 19, 20, 21	1,138,944
stony loam	Kansas 9	832
Total		1,139,776

For key to numbers in this column see p. 733.

Union series.—The soils of this series are characteristically brown to grayish brown in color, of silty texture and friable structure, with yellowish brown, silty, and moderately friable subsoils, frequently mottled in the lower part. In some places the subsoil has a light chocolate-brown color. In the more nearly level areas where the drainage is not so perfectly established the color of the soil varies to gray or grayish brown and the subsoil to a mottled gray and yellow, occasionally with shades of yellow and brown. Oxide of iron concretions are usually abundant in such situations. In places the soil carries an appreciable amount of sand, while the subsoil may be noticeably sandy. The origin of the soil material is not thoroughly understood. It is possible that the uniform brown friable silt loam is of loessial origin. The sand unquestionably is derived from sandstone, particularly from the Crystal City formation. Limestone probably enters into the composition, especially in situations where the subsoil is heavier. Areas having a sandy subsoil and sandstone fragments on the surface have a more rolling topography where the possible foreign constituent (loessial material) has been removed in part or entirely in a way to make the sandstone a more prominent factor in the formation of the soil. The subsoil material is probably largely residual from limestone and sandstone.

The topography is gently rolling to hilly, with considerable erosion on the steeper slopes. Drainage is good and the soils easily tilled. Where erosion is held in check and the organic-matter supply maintained, good results are had with the general farm crops, apples, and berries. These soils are characteristically developed in the northeastern portion of the Ozark Plateau. They resemble loessial soils more closely in their development near the Missouri River.

Area and distribution of the soil of the Union series.

Soil name.	State or area.[1]	Acres.
Union silt loam	Missouri 8	254,528

[1] For key to number in this column see p. 733.

Volusia series.—The soils of the Volusia series are the result of the feeble glaciation of the shales and sandstones of the Devonian and the Upper Carboniferous rocks of eastern Ohio, southern New York, and northern Pennsylvania. In all cases the underlying shales and sandstones have given rise to a large proportion of the soil material, which has been modified in varying degrees by glacial material from other regions. They occupy the upland portion of the plateau country which slopes north and west from the Allegheny Mountains. In the higher, more easterly portions of the glaciated section of the plateau, deep preglacial erosion has cut the upland into rounded or flat-topped hills separated by deep, steep-sided gorges. Farther west, where the elevations are less, this topography is not so pronounced, the series occupying rolling hills divided by deep valleys. All of the members of the series are well adapted under cultivation to the production of timothy and small grains, particularly oats and buckwheat. At lower elevations wheat and corn give good yields. Potatoes are also quite extensively grown on some of the types.

Area and distribution of the soils of the Volusia series.

Soil name.	State or area.[1]	Acres.
Volusia loam	New York 1, 6, 9, 13, 15, 18; Ohio 1; Pennsylvania 7	599,650
stony loam	New York 15; Pennsylvania 7	13,184
shale loam	New York 6, 13, 18	44,388
gravelly loam	New York 6, 13, 15; Pennsylvania 4, 7	45,760
silt loam	Indiana 9; New York 2, 3, 6, 9, 11, 13, 15; Ohio 10; Pennsylvania 4, 7.	1,364,928
clay loam	New York 15; Pennsylvania 7	105,088
undifferentiated	Pennsylvania 13, 14, 16	3,927,680
Total		6,100,678

[1] For key to numbers in this column see p. 733.

Wallpack series.—These soils are light yellowish gray to almost white, with pale yellow subsoils. They are formed from the till derived from sandstones and shales, influenced to a larger extent by the inclusion of limestone material than is the case with the Volusia series. The series occupies ridges or hills of rolling or sloping to hilly topography, with good surface drainage. Shaly and possibly cherty fragments will be found in the section of some of the members of the series. In general topography, occurrence, and origin of the material these soils much resemble the Cazenovia. They are, however, much whiter in color and are apparently the glacial representative of the Frankstown.

Area and distribution of the soils of the Wallpack series.

Soil name.	State or area.[1]	Acres.
Wallpack fine sandy loam	New Jersey 2	1,408
stony loam	do	1,664
shale loam	do	2,176
silt loam	do	7,232
Total		12,480

[1] For key to number in this column see p. 733.

Wethersfield series.—These soils are reddish to light reddish brown in color, with reddish subsoils. The texture and structure of soil and subsoil are much alike, the latter being slightly the heavier. The lighter types contain large and small bowlders, mainly of red and brown sandstone. The topography is hilly, the types occurring mainly along the slopes of the trap ridges in the Glaciated Triassic area of New England. The material is derived mainly from the Triassic rocks more or less modified by glacial action.

Area and distribution of the soil of the Wethersfield series.

Soil name.	State or area.[1]	Acres.
Wethersfield loam	Connecticut 1; Massachusetts 1	109,116

[1] For key to numbers in this column see p. 733.

Whitman series.—The soils of the Whitman series are brownish gray to almost black on the surface, grading into lighter grays mottled with yellows and browns in the subsoils. The soil and subsoil often contain stones and small bowlders. The topography is flat or depressed, the soils occurring as narrow strips bordering small streams where drainage is imperfectly established or as basin-shaped areas not connected with stream drainage. The soils are formed from glacial till, or to a less extent from glacial lake and river terrace material, the types being developed where the lack of drainage favors the accumulation of organic matter insufficient in amount to produce true Muck. A slight amount of material is also probably contributed by wash from higher-lying areas as alluvium or colluvium, though this source of supply is of minor importance. The soils will often be found intervening between Muck areas and the upland, in this respect corresponding to some of the nontypical areas of Clyde soils which have in the past been mapped in some of the Northern and Central States. Where properly drained these soils will be found to have a fair agricultural value for grass, corn, and some of the heavier truck crops.

Area and distribution of the soils of the Whitman series.

Soil name.	State or area.[1]	Acres.
Whitman sandy loam	Massachusetts 2	8,192
loam	do	4,736
Total		12,928

[1] For key to number in this column see p. 733.

Williams series.—The soils of this series are prevailingly of a dark-gray to brown or dark-brown color, generally underlain at 8 to 12 inches by lighter brown subsoils, which grade quickly into light-gray, ashen, or putty-colored subsoils of calcareous character and usually of fine and often of silty texture. They are of glacial origin, derived from a variety of rocks, and marked by the presence of rounded or flattened gravel, cobbles, or bowlders from the more resistant igneous rocks. The calcareous material of the subsoils has been derived from limestone rocks and has been subject to further concentration by leaching and decomposition from percolating waters often incrusting the gravels. The surface is treeless and varies from level prairies of the ground moraine to rough, hilly terminal morainic belts dotted with glacial meadows and lakes. In the vicinity of the infrequent stream valleys the surface is often dissected by intermittent streams. The soils of the Williams series are similar in general characterstics and may be considered the semiarid prototypes of the soils of the Carrington series, from which they differ essentially in the lighter color of the soil and subsoil, due to the diminished effect of leaching and the incorporation of less organic matter resulting from a more restricted rainfall.

Area and distribution of the soils of the Williams series.

Soil name.	State or area.[1]	Acres.
Williams loam	North Dakota 11	272,256
stony loam	do	69,888
undifferentiated	North Dakota 10	14,004,864
Total		14,347,008

[1] For key to numbers in this column see p. 733.

Worth series.—The soils are light brown or yellowish brown in color, overlying subsoils of similar or slightly lighter color and occasionally mottled. More or less angular, relatively thick-bedded arenaceous shale will be found in the soil and subsoil of most members of the series. The material is derived from glaciation of the thicker bedded shales of the Hudson River and possibly other formations of the Ordovician period lying north of the Allegheny Plateau. The topography is rolling to hilly and somewhat rough, with elevations ranging to over 1,500 feet, although usually less than that of the Volusia soils.

Area and distribution of the soils of the Worth series.

Soil name.	State or area.[1]	Acres.
Worth loam	New York 5	24,384
stony loam	do	1,344
silt loam	do	16,128
Total		41,856

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The agricultural possibilities of the sand group of this province are usually much underestimated. It is true that the water-holding power of these soils is small as compared with that of the loams, silt loams, and heavier textured soils, but with increase in knowledge of the best methods for the conservation of moisture by dry-farming methods they are being found capable of producing much larger, better, and surer crops, even of the staples, than was formerly considered possible. The ease with which they can be cultivated proves an attraction to many, and a large outlay for the heavy teams and tools necessary to handle heavy textured soils is avoided. The cost of draining this class of soils is also small. Their open structure enables the planting of crops from one to two weeks earlier than on heavier types, correspondingly lengthening the growing season. The sands offer ideal opportunities for the production of certain intertilled crops, such as navy beans, potatoes, sweet corn, etc., in the care of which, by the practice of frequent cultivation, a protective dust mulch will assure the crop of sufficient moisture to bring it to maturity in any but the driest seasons.

Soils of this texture are not so well suited to small grains and grasses, though surprisingly good yields of rye, oats, buckwheat, timothy, and clover are secured on the Coloma sand in some of the areas where the annual rainfall is above 30 inches and is fairly well distributed through the growing season. Some areas of the Coloma and Miami sand are too rough for the use of certain kinds of farm machinery.

All of the sandy soils are relatively deficient in organic matter and should receive liberal applications of barnyard manure and small and frequent applications of lime. Green crops of clover, Canada field peas, or rye should be plowed under.

Coloma sand.—The surface soil, to a depth of about 6 to 10 inches, consists of a light-brown, slightly loamy sand from 6 to 10 inches deep. The subsoil is a yellow, slightly loamy medium sand which frequently becomes coarser

in the lower portions. Fine gravel is often encountered in the subsoil, and gravel beds may be found at depths below 30 to 36 inches. The type occupies gently to steeply rolling country and includes a number of low, rounded ridges and hills, and in some cases the intervening plains. The type represents residuary material resulting from the reworking of glacial till by wind and water. Owing to its open structure the type is not very retentive of moisure and crops are liable to suffer in dry seasons. When liberally supplied with organic manures, rye, corn, and oats give moderately good yields. Potatoes, small berries, and grapes do fairly well. The type is probably best suited to the production of potatoes and some of the earlier vegetables.

Knox sand.—The soil consists of yellowish-brown to brown medium sand, having an average depth of about 10 inches. The subsoil is a yellowish-brown medium sand. The surface configuration varies from gently rolling to the topographic forms resulting from the action of the wind. Corn, wheat, oats, and sugar beets are grown, but give only moderate yields. Melons, sweet potatoes, and other garden truck do particularly well. Alfalfa has been successfully grown, although it is rather difficult to get a good stand.

Miami sand.—The type consists of a yellowish to brownish-gray, medium sand about 8 inches in depth, underlain by lighter colored, loose, incoherent sand of the same texture. Comparatively little stone occurs in this type, although cobbles and gravel are found in small quantities in local areas. The topography is rolling to sometimes hilly, the areas not infrequently lying upon moraines. The drainage is so free that the soil is droughty and the agricultural value of the land is lower than where composed of the Miami types of finer texture. In moist seasons such crops as rye, corn, and potatoes produce fair yields.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Coloma sand	Indiana 6; Michigan 1, 2, 3, 4, 7, 8, 10; Minnesota 2; Ohio 10; Wisconsin 11, 13, 16.	1,178,568
Knox sand	Indiana 3, 8	8,192
Miami sand	Wisconsin 15	1,920
Total		1,188,680

[1] For key to numbers in this column see p. 733.

GRAVEL PHASE.

The gravel soils of this province are so coarse, loose, and leachy in character and contain so little of finer interstitial material that they are exceedingly droughty and, with the exception of small local areas, possess little agricultural value. Some scanty pasturage is afforded, and their best use is in grazing or forest land. Some fruit is grown in favorable locations where the drainage is not excessive.

Carrington gravel.—The soil is a dark brown to black sandy loam containing a large proportion of coarse sand and fine gravel. At a depth of about 8 to 18 inches this is underlain by a band of coarse sand and fine gravel, usually several feet in thickness. The type occurs as knolls and ridges and is found capping high elevations. The soil is mainly derived from glacial till, though probably including some water-assorted kame and esker material. The agricultural value of the soil is low, as it is inclined to be droughty.

Coloma gravel.—The type consists of brown sandy loam, ranging in depth from 8 to 16 inches and underlain by a heterogeneous mixture of sand, gravel, and bowlders. The type occurs as well-rounded hills or knolls and as narrow, choppy ridges. The material represents residuary products derived from the weathering of glacial till, including some assorted drift. The loose character of the material and rough surface configuration render the type practically nonagricultural. The greater portion is timbered with hardwood and is used for pasturage.

Judson gravel.—This type consists of a dark-colored sandy gravel underlain by lighter colored material having ordinarily a higher content of clay than the surface soil. The gravel content is so high that the soil is exceedingly droughty. The type occupies steep slopes and represents outcroppings of gravel strata in

the glacial till, or colluvial material washed therefrom. Near the foot of slopes there may be bands of colluvial gravelly soil of a somewhat more loamy nature. The major part of the type has a low agricultural value. Some fruit can be grown successfully where the slope is not too steep.

Miami gravel.—The type consists of a gray to brown gravelly loam or slightly sandy loam. Cobbles, gravel, and bowlders form a large part of the soil mass. They consist of angular and sometimes rounded fragments of granite or gneiss, with a considerable proportion of limestone. The topography is usually hummocky, with rounded hills and knolls, which form a part of the moraines. Erosion is active in many localities, and the agricultural use of the type is limited. Its principal value is for pasturage.

Rodman gravel.—The surface soil of the Rodman gravel consists of a yellowish brown to brown sandy loam about 8 inches deep, containing considerable gravel. The subsoil is somewhat lighter in color than the soil and consists of a mixture of sand, gravel, cobbles, and bowlders. The type is a leachy soil and subject to drought. It is derived from stratified or assorted drift deposits, with rolling to hilly topography. It supports a growth of scrub oak and is of practically no value except for scanty pasturage.

Area and distribution of the gravels.

Soil name.	State or area.[1]	Acres.
Miami gravel	Wisconsin 15	20,672
Judson gravel	Illinois 10, 11; Wisconsin 6	15,296
Coloma gravel	Wisconsin 12	6,080
Rodman gravel	Wisconsin 4, 8	5,568
Carrington gravel	Minnesota 4; North Dakota 1	2,560
Total		50,176

[1] For key to numbers in this column see p. 733.

STONY SAND PHASE.

The interstitial material of this phase is similar in texture and in moisture-holding power to the main sand group. On account of the predominantly rougher, more broken morainic topography and the presence of numerous cobbles, stones, and bowlders, however, the phase is of much lower agricultural value. The steep slopes, combined with the abundance of stones, in many places preclude the use of farm machinery, so that many areas still remain in scrub-oak forest. Small, irregular areas can be cultivated and produce light yields of rye, oats, buckwheat, potatoes, etc. On the whole, the best use of the type is for pasturage and forestry.

Coloma stony sand.—The soil to an average depth of about 8 inches consists of a light-brown or yellow medium sand. The subsoil is a loose, yellow medium sand. Stones are so abundant and the topography so rough that the type has little agricultural value. The soil represents residuary material, consisting of the weathered products of glacial till. Rye, buckwheat, corn, and grass are grown on some of the less uneven areas, but the yields are small. The type is best suited to pasturage and forestry.

Plymouth stony sand.—The type consists of a gray or brown sand of coarse to medium texture carrying considerable quantities of fine gravel and scattered bowlders. The subsoil is a yellow gravelly sand, grading at 18 inches into coarse sand, gravel, and stone. Portions of the surface material are of wind-blown origin, while the lower subsoil is glacial. The type is developed upon moraines and the topography is rolling to hilly. The soil is so porous and leachy as to be of little agricultural value.

Rodman stony sand.—The interstitial material of this type consists of a light-brown, yellowish-brown, or grayish sand about 8 inches deep. The subsoil is a yellowish-brown sand or light sandy loam. Usually the entire soil mass is loose and incoherent. Distributed throughout the profile are numerous glacial bowlders, stones, and gravel of various origin. These are so abundant as to render the type of slight agricultural value, though where not too numerous light yields of general farm crops and special crops are secured. The topography is rolling to somewhat hilly, the soils mainly consisting of kame and esker deposits, and also including wave-washed moraines in the beds of glacial lakes, where there also has been considerable reworking and assorting of the original till material. Drainage is usually excessive and the soil is droughty.

Area and distribution of the stony sands.

Soil name.	State or area.[1]	Acres.
Coloma stony sand	Michigan 1, 7; Wisconsin 16	26,166
Rodman stony sand	New York 5	6,784
Plymouth stony sand	New York 7	5,376
Total		38,326

[1] For key to numbers in this column see p. 733.

GRAVELLY SAND PHASE.

This group is unimportant from an agricultural standpoint. The large gravel content in the soil and subsoil make the soils porous and leachy, the moisture soon escaping beyond the reach of capillary action. Crops suffer correspondingly in all but the wettest seasons. Some of the areas are unsuited for the production of field crops on account of their rough, broken topography. Light yields of general farm crops are secured, although fruit, particularly peaches, does well where favored by climatic conditions and location.

Coloma gravelly sand.—This type consists of a brown gravelly sand, grading at a depth of 8 to 12 inches into a yellow coarse sand ordinarily carrying a considerable amount of fine gravel. The type occupies high ridges and knolls. Drainage is thorough and crops are inclined to suffer in dry weather. The soil is composed of glacial material, reworked by wind and water, and deposited over glacial till. Rye is the most common general farm crop. In moist seasons and on favorably situated areas some of the earlier fruits and vegetables are grown with good results.

Rodman gravelly sand.—The surface soil consists of a yellowish-brown, loose fine sand containing considerable gravel. The subsoil is a yellowish fine sand, frequently becoming coarser at a depth of 3 feet and often stratified with layers of gravel. The material is derived from kame and esker deposits. The topography is rolling to hilly and broken by knolls and ridges. It is a poor soil and very little of it is in cultivation.

Area and distribution of the gravelly sands.

Soil name.	State or area.[1]	Acres.
Coloma gravelly sand	Michigan 1, 6, 7; Wisconsin 1, 16	34,890
Rodman gravelly sand	Wisconsin 4	640
Total		35,530

[1] For key to numbers in this column see p. 733.

FINE SAND GROUP.

This group of soils, while too light in texture and porous in the subsoils for the profitable production of the staple farm crops, is exceptionally well adapted to the growing of early summer truck crops. By reason of the more northerly latitude these crops reach the markets at a time when most of the winter and spring grown vegetables from the South have been harvested and consumed. The soils are always well drained and warm up early in the spring, making it possible to mature crops as soon as upon the soils of the sand group. For sweet corn, cantaloupes, sweet peppers, sweet potatoes, and tomatoes, in the more southerly latitudes, the Coloma and Knox fine sands are preferable to the corresponding types of the sand group. Under favorable climatic conditions, such as are found along the shores of some of the Great Lakes and other bodies of water, where comparative immunity from damaging frosts is assured, peaches and several of the small fruits are profitably grown. In seasons of more than normal rainfall fair yields of corn, rye, and potatoes can be secured. Some of the rougher glacial hills of Coloma fine sand are too broken in topography to be used for crops requiring much tillage, but can be seeded to grasses and will yield a small amount of pasturage. Like the sand group, these soils are defi-

cient in organic matter, and the liberal addition of barnyard or green manures, together with some lime, is required to secure the best results.

Coloma fine sand.—The type consists of a light-brown loamy fine sand from 6 to 10 inches deep underlain by rather loose, yellow loamy fine sand. It occupies rolling country, with rounded hills and undulating areas. The soil is a residuary product from the weathering of glacial till. The type is so completely drained that crops suffer in dry seasons. The soil is best suited to small fruits and vegetables. Fair yields of corn and clover are made in wet years.

Knox fine sand.—The soil consists of a light-brown to pale-yellow loamy fine sand from 10 to 14 inches deep. The subsoil is a yellow or pale-yellow loamy fine sand. The type occurs along slopes and as hillocky uplands. Drainage is good. The material forming the type has been deposited through wind action. Moderate yields of corn and oats are secured. The type is best suited to the production of truck crops, such as watermelons, cantaloupes, early peas, tomatoes, potatoes, etc.

Marshall fine sand.—The type consists of a dark-brown to black, rather incoherent sand of fine texture from 10 to 12 inches deep, resting on a lighter colored sand of about the same texture. It occupies low bluffs and hills of broken and rolling topography, and the drainage is apt to be excessive, especially over the deeper areas of sandy subsoil. The type is primarily of windblown origin. The crop value varies greatly, depending mainly upon moisture conditions. The soil is best adapted to early truck crops and melons. With liberal applications of manure good yields of Irish potatoes can be secured.

Miami fine sand.—The soil to an average depth of about 8 inches is a fine sand, light brown or slightly grayish brown in color, and rather loose and incoherent in structure. The subsoil is a yellowish fine sand, containing little gravel, although a small amount is present in some places. The topography varies from undulating to rolling or hilly, and the surface drainage and subdrainage are good. The material is derived from sandy glacial till deposited either as ground moraine or terminal moraine, more often the latter. The type is inclined to be droughty and is not well adapted to the small grains, though rye gives fair yields in moist seasons. With the application of liberal quantities of barnyard manure fair to good crops of corn can be secured.

Rodman fine sand.—The soil to an average depth of about 6 inches is a grayish-brown or yellowish incoherent fine sand. The subsoil is a loose, yellowish-brown fine sand, somewhat finer in texture than the surface material. A gravelly clay is encountered at depths ranging from 5 to 10 feet, which usually grades into very gravelly and stony material. A small amount of gravel is sometimes scattered through the surface soil and subsoil. The topography is gently rolling, and on account of the sandy nature of the material the natural drainage is excessive and the type droughty. The native timber growth is chiefly white pine, with some hemlock and a few varieties of hardwoods. The type is better suited to the production of early truck crops than to general farming.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Coloma fine sand	Illinois 11; Michigan 1, 3, 6; Minnesota 2; Wisconsin 3, 10	247,820
Knox fine sand	Illinois 8, 10; Indiana 10; Iowa 4; Nebraska 6; Wisconsin 9	93,888
Miami fine sand	Wisconsin 3	43,584
Marshall fine sand	Iowa 3; Minnesota 1; North Dakota 2	23,040
Rodman fine sand	Wisconsin 8	1,024
Total		409,356

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

This group includes the coarsest textured soils which under ordinary conditions can be profitably used for the production of the staple farm crops. The soils are too light in texture for good results with such crops as wheat, and give only light to fair yields of hay. They are very well adapted to oats, potatoes, and beans, however, and are in quite general use for corn, barley, millet, and flax. Nearly all the root crops do well. Their profitable utilization

for tomatoes, melons, cucumbers for pickling, and other heavier, later varieties of truck, as well as for fruit, especially apples and peaches, has been well established. The Carrington, Coloma, Gloucester, Portage, and Bangor soils possess the most retentive subsoils of any in the group, and are best adapted to the general farm crops, such as corn, oats, beans, and potatoes.

Bangor sandy loam.—The soil consists of a light-brown rather heavy sandy loam from 8 to 10 inches deep. The subsoil is a very light-brown or brownish-gray sandy loam, 3 feet or more in depth. Both soil and subsoil are filled with rounded, waterworn, and subangular stones and gravel of quartz, granite, sandstone, and shale. The type occupies low hills and the more level portions of higher elevations. The topography is rolling to slightly hilly. The type is derived from deep glacial till. The soil is loose, friable, and easily cultivated, and where the topography is suitable is well adapted to general farm crops, including potatoes.

Carrington sandy loam.—The soil is a dark-brown to black heavy sandy loam from 10 to 16 inches deep, the lower portion being somewhat lighter in color. The subsoil is usually a yellow clay loam to clay. Gravel and bowlders in small quantities are scattered over the surface and disseminated throughout the soil mass. The type occupies gently rolling prairie land, frequently occurring as hillocks and sometimes as narrow ridges. The soil represents residual products from glacial till. It is well suited to general farming, giving good yields of wheat, oats, flax, rye, barley, millet, and potatoes. Clover and timothy do especially well on the heavier phases.

Coloma sandy loam.—The soil consists of a grayish-brown to brown moderately heavy sandy loam, ranging in depth from 8 to about 10 inches. The subsoil is a yellowish brown moderately heavy sandy loam, sometimes resting upon a stratum of lighter colored coarser material at depths ranging from 24 to 30 inches. This lower stratum frequently carries a considerable amount of gravel. Fine gravel is of common occurrence throughout the soil mass. The topography varies from gently rolling to hillocky or even sharply rolling. Drainage is good. The soil consists of the weathered product of sandy glacial till. The type is fairly well suited to corn, oats, wheat, grass, and potatoes. Vegetables give fairly good results. Green manuring should be practiced in order to maintain a proper supply of organic matter.

Gloucester sandy loam.—The soil is a brown sandy loam about 8 inches deep, overlying a yellowish-brown, slightly less coherent sandy loam to a depth of 30 inches, where a light yellowish-gray sandy loam or loamy sand is encountered. Stones and small bowlders, chiefly of granite or gneiss, are usually present. Small subangular gravel is often found throughout the soil mass. The topography varies from gently undulating to somewhat hilly, the type for the most part occupying low rounded ridges and hills. Drainage is good. The original timber growth consisted mainly of white pine, white maple, and oak. In second-forest growth birch is common. Corn, oats, and rye with grass for hay and pasturage give the best results. Fruit is also profitably grown.

Knox sandy loam.—The type consists of a gray to dark-brown heavy sandy loam, ranging from 6 to 12 inches in depth, resting upon a yellowish-brown loamy sand to light sandy loam, which sometimes passes into clayey material at depths of 20 to 30 inches. The soil material is mostly wind deposited. The surface configuration is characterized by knolls and ridges, subject to shifting through wind action. Fair yields of grain and grass are secured. Truck crops and some fruits give good results.

Marshall sandy loam.—The soil consists of a dark-brown to black compact sandy loam, about 10 inches in depth, underlain by yellowish sandy loam with a high content of coarse sand and gravel. Rounded pebbles and bowlders occur on the surface, and partly decomposed calcareous nodules in the subsoil. The type occupies gently rolling prairie ridges and intervening depressions and is mainly of glacial origin. It is a good general farming soil, although inclined to be droughty in local areas. Wheat yields from 12 to 20 bushels, oats from 20 to 35 bushels, flax from 12 to 15 bushels, and potatoes from 100 to 125 bushels to the acre.

Miami sandy loam.—Typical areas of this soil consist of a yellowish-brown medium-textured sandy loam about 10 inches deep, resting upon a subsoil of more pronounced yellow than the soil, which becomes heavier with depth and grades into a sandy clay at 18 to 26 inches. In exceptional cases the lighter-textured material extends to a depth of about 3 feet. The topography is gently rolling and the soil relatively free from bowlders. It is derived from the

weathering of glacial till. The type is apt to be somewhat droughty and is devoted to the general farm crops.

Plymouth sandy loam.—The soil is a brown to gray loose sandy loam from 6 to 12 inches deep, carrying gravel and rounded bowlders, the content increasing with depth. The interstitial material is often a gray or yellow sand. The bowlders are of trap, granite, gneiss, and other crystalline rocks, together with some sandstone. The type occurs as lenticular hills in the morainic uplands and as terrace remnants along some of the larger stream valleys, though the former features are the most typical. The topography is rolling to hilly, with numerous kettle holes and depressions. The soil material has been derived from coarse-textured glacial till deposited along the morainal front, typically on Long Island and along the southern border of the New England States. The agricultural value of the type is low on account of the porous character of the soil and subsoil. Tree fruits should do well in carefully selected locations.

Portage sandy loam.—The soil to a depth of from 8 to 9 inches is a grayish-brown sandy loam of fine to medium texture. Below this occurs a brownish-yellow sandy loam grading in the lower part of the profile into a mottled gray and yellow sandy clay. The topography varies from gently rolling to nearly level, the latter areas being rather poorly drained. The type is derived from glacial drift modified by an intermixture of residual material from crystalline rocks. It is adapted to general farm crops, yielding 1½ tons of hay, 100 bushels of potatoes, 30 bushels of corn, 40 bushels of oats, and 10 to 15 bushels of rye per acre. Small fruits and vegetables also do well.

Rodman sandy loam.—The soil is a light-brown, yellowish-brown, or grayish sandy loam about 8 inches deep, overlying a light-brown or yellow sandy loam. Numerous small stones and fine gravel, together with some coarse sand, occur in the subsoil, making the type somewhat droughty. The topography is rolling to somewhat ridgy, the type occurring as kames and eskers, including moraines subjected to glacial lake action subsequent to their original formation and deposition as till material. It is adapted to corn, oats, hay, and potatoes.

Whitman sandy loam.—The soil is a dark-gray or brownish-gray to black sandy loam about 8 inches deep, resting upon a mottled gray, yellow, and brown sandy loam or heavy sandy loam subsoil, often becoming somewhat lighter in texture in the lower part of the profile. Cobblestones and larger bowlders of granite or gneiss frequently occur at the surface and in the subsoil. The type occupies flat areas or depressions and is poorly drained. Oak, pine, maple, and birch constitute the natural timber growth. Where properly drained, corn, hay, and heavy truck crops can be grown.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Coloma sandy loam	Michigan 1, 3, 4, 6, 7; Minnesota 2; Wisconsin 6, 11, 13, 16	538,228
Carrington sandy loam	Illinois 11; Kansas 2; Minnesota 5; North Dakota 3; South Dakota 2.	208,384
Plymouth sandy loam	New York 7; Rhode Island 1	170,560
Gloucester sandy loam	Massachusetts 2; New Jersey 2	56,320
Bangor sandy loam	Maine 2	37,184
Knox sandy loam	Indiana 3; Iowa 2	25,984
Rodman sandy loam	New York 5; Wisconsin 8	23,936
Portage sandy loam	Wisconsin 11	9,792
Whitman sandy loam	Massachusetts 2	8,192
Marshall sandy loam	Minnesota 4	3,008
Miami sandy loam	Wisconsin 4	1,280
Total		1,082,868

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

The prevailingly rough, morainic topography and the superabundance of stones, together with the light texture of the fine earth portion of the soil mass, make this phase one of little agricultural value. Where the surface is not too broken for cultivation the yields of such crops as corn, oats, and potatoes are light to fair, depending upon the texture and moisture-holding capacity of the subsoils. The Dover and Portage types are the most productive, the drift of

the former being influenced to some extent by the underlying limestone, making it better adapted to grass than the other types. The greater proportion of the stony sandy loam phase should be reforested.

Adirondack stony sandy loam.—The soil consists of a brown to yellowish-brown, loose, fine sandy loam, about 5 inches deep, underlain by a lighter-colored fine sandy loam. Angular fragments of granite, gneiss, and sandstone, with a few foreign glacial bowlders, are found throughout the soil section. The type is derived from the glaciation of the Adirondack Mountain masses and occurs as moraines, modified by colluvial and local wash from higher lying positions. The topography is hilly to mountainous. This soil is light in texture and often droughty. It is adapted to corn and potatoes, though its best use is for pasturage or forest products.

Dover stony sandy loam.—The soil consists of 8 to 10 inches of a brown sandy loam, overlying a subsoil of light-brown to yellow sandy loam. Both soil and subsoil are more or less filled with glacial stones and bowlders. Areas of this type occur as low, rounded hillocks of glacial drift, overlying limestone which contributes to the stone content. This soil is adapted to corn, potatoes, oats, hay, and tree and small fruits.

Gloucester stony sandy loam.—The soil consists of a light-brown to brown medium to fine sandy loam about 8 inches deep, underlain by a medium to fine yellow sand or, in some places, light sandy loam extending to an average depth of 18 inches. Small flakes of mica are generally present in both soil and subsoil. Scattered over the surface and through the soil and subsoil and becoming more abundant at the depth of 20 inches are glacial bowlders of all sizes and mostly of angular or subangular forms. There is also more or less gravelly material upon the surface and throughout the profile. The type occupies the tops and slopes of hills. It is of glacial origin. It seems to be fairly well adapted to the production of corn, oats, and grass crops. Apples do well in favorable situations, but the greater part of the type is best suited for pasture land.

Plymouth stony sandy loam.—The type consists of a grayish or brownish sandy loam about 8 inches deep, underlain by a light brown, somewhat coarser textured sandy loam, assuming a yellowish-gray color in the lower portion of the subsoil. Angular fragments and bowlders of granite and gneiss are scattered over the surface and throughout the soil mass, and in some places there is more or less small gravel. The type occupies areas of hilly to rough morainic topography. The surface drainage is thorough, and this, with the somewhat porous subsoil, makes the type as a whole rather droughty. The original forest growth included considerable white pine, but the second growth is largely composed of stunted oak and pitch pine. Some of the type can be made to produce apples. As a whole it is of little value for farming and used principally for pasture lands.

Portage stony sandy loam.—The soil is a rather loose, dark-gray or brown sandy loam of medium to fine texture and from 8 to 10 inches deep. The underlying material is a yellowish-brown or gray sand of fine to medium texture continuing to a depth of 30 inches, where a yellow or gray sandy clay is sometimes encountered. Bowlders, principally of granite, are found on the surface and outcrops of the underlying crystalline rocks from which the type is in part derived are of frequent occurrence. The type is derived principally from glacial till influenced locally by residual material from the underlying crystalline rock. The topography varies from generally level to gently rolling, much of it being quite level and including many swampy depressions. Drainage is rather poor and the type used mostly for pasturage.

Area and distribution of the stony sandy loams.

Soil name.	State or area.[1]	Acres.
Gloucester stony sandy loam	Massachusetts 2; New Hampshire 1, 2; New Jersey 2	112,640
Adirondack stony sandy loam	New York 16, 17; Vermont 1	59,456
Plymouth stony sandy loam	Massachusetts 2	19,520
Portage stony sandy loam	Wisconsin 11	11,392
Dover stony sandy loam	New York 17	5,056
Total		208,064

[1] For key to numbers in this column see p. 783.

GRAVELLY SANDY LOAM PHASE.

The areas of gravelly sandy loam texture generally occupy rough, rolling country formed of glacial moraines and kames, and in cases the more level terrace deposits. The soils are light in texture and easily cultivated, except in a few of the most gravelly and stony areas. The subsoils are in some cases rather heavier than the surface soils, but are often underlain by gravel deposits, so that on the whole the phase is rather porous and leachy and crops suffer in dry weather. Some areas give fair results with the general farm crops in moist seasons, but as a rule the yields are light. The phase is best adapted to special truck crops and such fruits as peaches and small fruits, depending upon the locality and climatic conditions.

Carrington gravelly sandy loam.—The surface soil consists of a dark-gray to nearly black light loam to heavy sandy loam carrying considerable amounts of coarse sand and fine gravel. The subsoil proper, encountered at an average depth of 10 inches, consists of a yellowish sandy loam to loam containing small gravel, the content of which increases with depth. In a few nontypical areas an underlying gravel stratum is encountered. The topography is broken to hilly, embracing morainic knolls and hills. Drainage is good, except in some of the lower depressions. Bowlders of granite, gneiss, schist, and limestone are frequently encountered. Fruit and a number of vegetables give very fair results. Wheat, oats, and flax are grown, but the average yields are only moderately good.

Coloma gravelly sandy loam.—The soil consists of a brown gravelly sandy loam, having an average depth of 10 or 12 inches. The subsoil ranges in texture from sandy loam to fine gravel. Small rounded stones are of common occurrence on the surface and throughout the soil. The lower subsoil quite often consists of loose gravel. The type occupies hilly to rough country, usually containing many knolls and ridges. The material represents residuary products derived from the weathering of the till by atmospheric agencies. General farming is practiced on much of the type and fair crops are produced. Oats, corn, and hay are most commonly grown. In favorable locations the type is a desirable soil for peaches, grapes, and small fruits. Potatoes and a number of vegetables also give good returns.

Miami gravelly sandy loam.—The soil to a depth of 8 inches is generally a light-brown sandy loam with a high content of gravel and frequently of small stones. The subsoil varies from a sticky, sandy loam to a gravelly sand, and is often underlain at a depth of 2 to 3 feet by a bed of gravel. The surface is rolling and the type often occurs as rounded knolls or hills, generally composed of stratified and unstratified sands, clays, and gravel. It is of glacial origin, and often represents morainic material. Where cultivated, the crop yields are only fair. It is not adapted to general farming, though fairly well adapted to the lighter crops and the production of small fruits. In favorable localities peaches do well on this soil.

Ontario gravelly sandy loam.—The soil of this type consists of about 10 inches of brown fine sandy loam containing considerable quantities of rounded and some angular gravel and stones. The subsoil is rather lighter in color and texture than the soil and also contains numerous gravel and stones. On account of the looseness in texture of the subsoil and the topography, which is rolling to quite hilly and rough, the drainage is usually excessive and some erosion occurs. The type is developed in areas of glacial moraines and kame hills. On account of the rough topography much of the type is not well adapted to agriculture, though some of the more favorably situated areas are suitable for the production of corn, potatoes, small grains, and a few fruits.

Rodman gravelly sandy loam.—The soil to a depth of about 8 inches is a grayish-brown or brownish-gray sandy loam in which is mixed varying amounts of small waterworn gravel. Occasional bowlders are also found at the surface interfering with cultivation to a certain extent. The subsoil is a reddish-brown or yellowish-brown to yellow sandy loam of heavier texture, grading into masses of sand and gravel at a depth of 36 inches. Many bowlders and smaller stones occur in the subsoil. These are largely of limestone, but some are of granite, quartz, and sandstone. The topography varies from gently rolling or ridgy to hilly and hummocky. This condition, with the porous subsoil of the type, makes drainage excessive in many places and the type as a whole somewhat droughty. The native forest vegetation is chiefly maple, beech, oak, and hickory, together with some pine and hemlock. The type is of low agricultural value and the greater proportion of it is best adapted to grazing.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Miami gravelly sandy loam	Wisconsin 15	51,520
Coloma gravelly sandy loam	Indiana 6, 10; Michigan 2, 3, 6, 7; Minnesota 2	40,768
Carrington gravelly sandy loam	North Dakota 9	10,048
Ontario gravelly sandy loam	New York 10, 13	6,080
Rodman gravelly sandy loam	Wisconsin 8	1,792
Total		110,208

[1]For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The capacity for the storage and delivery of moisture in the soils and subsoils of this group is sufficient to insure the maturing of many of the staple farm crops which can not be successfully grown on the sands, fine sands, and sandy loams. Though the texture of this group of soils is too light for the best results in the production of wheat, it is favorable for such cereals as corn, oats, and barley. Where the depth to ground water does not exceed 5 or 6 feet, alfalfa has given good results. Potatoes are particularly well adapted to soils of this texture, and navy beans, with sugar beets and other root crops, are profitably produced. The fine sandy loams are fair types for dairy farming, as good yields of forage and moderate yields of grass can be secured. The group is also well suited to market gardening and trucking, especially for growing the medium late varieties of vegetables, such as tomatoes, peas for canning, string beans, cauliflower, early cabbage, etc. It is among the most desirable textured soils for bush fruits and berries, and yields plums, cherries, and apples of fine quality. On account of the ease with which it can be worked and its relatively good drainage, it would seem to be more profitably utilized for gardening and fruit growing than for general farm crops where such use is warranted by market demands and transportation facilities.

Carrington fine sandy loam.—The soil consists of a dark-brown loamy fine sand ranging from 8 to 18 inches in depth. The subsoil is lighter colored or yellow and has about the same texture as the soil. Occasionally small gravel is encountered, particularly on the crests of knolls and ridges. The topography is characterized by disconnected morainal ridges and hills. Fair yields of wheat, corn, Irish potatoes, and clover are secured on the better-situated areas.

Coloma fine sandy loam.—The soil consists of a brown to light-brown heavy fine sandy loam about 12 inches deep containing a small proportion of fine gravel. The subsoil is a yellowish, somewhat sticky, heavy fine sandy loam containing some fine gravel; below 30 inches a gravel stratum is sometimes encountered. The type occupies low ridges and hillocks. The soil is composed of residuary material, representing the results of weathering of the glacial till. Drainage is good. Crops frequently suffer in hot weather on account of the droughty condition of the soil. Fair yields of general farm crops are secured. Vegetables give the best results.

Cossayuna fine sandy loam.—The soil consists of a brown, medium fine sandy loam from 8 to 12 inches deep, resting upon the magnesian limestone or calciferous sandstone rock, which has entered largely into the formation of the soil. Numerous irregular, angular fragments of this rock, together with scattered glacial stones and bowlders of foreign origin, occur throughout the soil. The topography is ordinarily level, though in some localities it may be undulating or rolling. Natural drainage is good and at times excessive. The shallower areas are often droughty. The type is of value for special crops, such as early truck, but is too uncertain in dry seasons to warrant its extensive use for general farm crops. It is well adapted to forestry.

Dover fine sandy loam.—The soil is a light-brown silty fine sandy loam about 8 inches deep, underlain by a yellow or reddish-yellow silty fine sandy loam which becomes sandier with depth. Both soil and subsoil have a greasy feel, owing to the presence of finely divided mica flakes. Some glacial gravel and bowlders are strewn upon the surface. The soil occupies low hills and ridges, knolls, and knobs. Outcropping ledges of rock are so numerous as to interfere with cultivation. Drainage is good and the type somewhat droughty. The material is of glacio-residual origin. The prevailing forest growth is cedar.

The type produces strong and lasting sod and makes excellent pasture. Cultivation is limited because of the rough surface and numerous rock outcrops.

Gloucester fine sandy loam.—The type consists of a brown, mellow, fine sandy loam, about 8 inches deep, resting upon a light-brown to brownish-yellow fine sandy loam subsoil, frequently grading into grayish yellow at a depth of 30 inches. Some fine angular or slightly rounded gravel is found in the soil, and stones and bowlders of granite, gneiss, and other crystalline rocks frequently dot the surface. The topography varies from gently undulating to hilly, with occasional steep slopes. Except in the more level areas the natural drainage is good. Corn, oats, hay, and potatoes do well. Some kinds of fruit are grown, especially apples.

Judson fine sandy loam.—The type consists of a black, dark-brown, or dark-gray silty fine sandy loam from 12 to 15 inches deep, underlain by a somewhat heavier fine sandy loam, lighter in color than the soil and extending to a depth of more than 3 feet. In places the subsoil is very silty, approaching the texture of a silt loam. The material is mainly of colluvial origin, but includes narrow strips of alluvium along the smaller streams and alluvial fans found in the margins of broad valleys at the point of confluence with smaller streams. The material is washed from glacial and loessial deposits. Good yields of corn, clover, and alfalfa are secured.

Kewaunee fine sandy loam.—The surface soil consists of a brown fine sandy loam with an average depth of 8 inches, underlain by a light-brown or yellowish-brown sandy loam of medium to fine texture. Considerable variation exists in the depth of the sandy loam portion of the section, but the underlying light red, slightly calcareous clay is usually encountered at depths of 2 to 3 feet. In places this clay reaches nearly to the surface. The topography is undulating to rolling. Drainage is generally good, except in the more level areas and where the red clay subsoil lies near the surface. The type holds moisture well. It is easily cultivated and yields fair to good crops of corn, oats, barley, rye, and potatoes.

Knox fine sandy loam.—The soil consists of a brown, heavy fine sandy loam underlain at a depth of 14 to 16 inches by a compact, light-brown to yellow heavy fine sandy loam to fine sandy clay. At a depth of 30 inches the subsoil usually grades into coarser material containing some fine gravel. The type occupies broken to hilly country, with occasional level areas. The soil represents wind-blown glacial material. Much of the type is excessively drained, causing crops to suffer in dry seasons. Corn, oats, wheat, and clover give moderately good returns. The soil is especially suited to the production of potatoes and other vegetables. Apples, peaches, and small fruits are grown to some extent.

Marshall fine sandy loam.—The soil consists of a dark-brown to black medium to fine sandy loam, with an average depth of 14 inches. It contains a high percentage of organic matter, but this decreases with depth, as does also the dark color. The subsoil is somewhat variable, but consists typically of a yellow medium to fine sandy loam containing considerable clay, becoming heavier with depth and grading into a mottled yellow sticky sandy clay. This in turn rests upon a bowlder clay at a depth of 3 or 4 feet. Occasionally layers of sand are encountered in the subsoil. The type is derived for the most part from glacial till modified by some aeolian material. The topography is undulating to rolling, and drainage, as a rule, ample. The soil is very productive and has a wide range of crop adaptation.

Miami fine sandy loam.—The soil consists of a loose, loamy, brown sand or sandy loam from 10 to 30 inches deep, the sand being from medium to fine in texture. The subsoil is a clay loam or sticky sandy loam. This type differs from the Miami sandy loam in having the heavy subsoil within 3 feet of the surface. The type is of glacial origin, occupies rolling country, often occurring as rounded hills and ridges, and has good drainage. The Miami fine sandy loam is a good corn soil. Wheat yields from 15 to 30 bushels, oats from 35 to 75 bushels, rye from 15 to 30 bushels, and hay from 1½ to 2 tons per acre. The soil is used for general agriculture, but is especially adapted to medium and late truck crops and fruit.

Ontario fine sandy loam.—This soil is a gray to yellowish-brown fine sandy loam about 10 inches in depth. The subsoil is a fine sandy loam of somewhat lighter color and looser structure, both the soil and subsoil carrying variable quantities of gravel and stones of glacial origin. The drainage of this type is excellent. The topographic features consist principally of elevated and nearly level plains flanked at lower elevations by kame hills and glacial moraines. The type is well suited to the production of potatoes, hay, wheat, oats, etc.

Wallpack fine sandy loam.—The surface soil is a light-brown to brown fine sandy loam, which is underlain by a light-brown to yellowish-brown fine sandy loam of somewhat heavier texture than the surface soil. Glacial stones and bowlders are scattered about over the surface and in the subsoil. The topography is gently to steeply sloping, the type occupying a subordinate ridge on the western side of Kittatinny Mountain in New Jersey. The subsoil is derived from glacial till, though the surface has been modified to some extent by more recent wind action. The surface and subsoil drainage is good. The type has not a high agricultural value on account of the stone content, its inherent droughtiness, and distance from markets. It is best adapted to pasturage. Oak and chestnut are the common native forest trees.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Miami fine sandy loam	Michigan 2, 5, 6, 7, 8; Wisconsin 3, 10, 15	388,160
Coloma fine sandy loam	Michigan 3; Wisconsin 3, 10	171,648
Ontario fine sandy loam	New York 5, 10, 13	157,696
Gloucester fine sandy loam	Connecticut 2	93,440
Carrington fine sandy loam	Indiana 7; Minnesota 1; North Dakota 8; Wisconsin 3	69,184
Marshall fine sandy loam	Indiana 10; North Dakota 2	33,280
Cossayuna fine sandy loam	Michigan 4; New York 5	24,896
Dover fine sandy loam	New Jersey 2; New York 4	9,024
Knox fine sandy loam	Indiana 10	4,608
Judson fine sandy loam	Missouri 12	4,096
Kewaunee fine sandy loam	Wisconsin 8	2,112
Wallpack fine sandy loam	New Jersey 2	1,408
Total		959,552

[1] For key to numbers in this column see p. 733.

STONY FINE SANDY LOAM PHASE.

This phase is an unimportant one, and though the mapping includes some relatively stone-free areas of undulating topography, where field crops may be grown, the greater proportion of it is too rough and stony for cultivation. On the whole, its best utilization is for pasturage and forestry purposes.

Gloucester stony fine sandy loam.—The soil is a brown fine sandy loam about 7 inches deep, grading into a light-brown or yellowish-brown fine sandy loam, which often passes into a yellowish-gray or brownish-gray lighter-textured sandy loam or loamy sand at 24 to 30 inches. Numerous stones and bowlders, many of large size, are scattered over the surface and in many places prohibit the reclamation of the land on account of the cost entailed by their removal. Drainage is apt to be excessive. The topography is hilly to rough and broken, and the type has little value, except for pasture land.

Area and distribution of the stony fine sandy loam.

Soil name.	State or area.[1]	Acres.
Gloucester stony fine sandy loam	Connecticut 2	93,952

[1] For key to number in this column see p. 733.

LOAM GROUP.

This group comprises the best general-purpose soils of the Glacial and Loessial province and, with the exception of the silt loam, has the widest areal distribution. The soils are well adapted not only to the general farm crops, but also to many of the heavier truck and market garden products. Where lighter-textured soils are not available upon the farm, the soils of this group reasonably fulfill the requirements for nearly all the vegetables needed in the supply of the home table. The topography is gently undulating to rolling, insuring fair to good surface drainage, although the crop yields are usually enhanced by tiling or ditching, especially over areas of heavier subsoils. Modern labor-sav-

ing machinery can almost always be used, making it practicable to grow cereal and grass crops requiring extensive acreages for their economical production. In most sections where the loams are found their development is usually so uniform that little waste land is included in the mapped areas.

A noticeable characteristic of the loams of this province, however, is the variable distribution throughout the soil section of angular and partially rounded stones and bowlders of limestone and shale or the more resistant granite, quartzite, and other crystalline rocks, many of which have been transported long distances by glacial action. This stone content is most common in the Miami, Volusia, Gloucester, Lackawanna, and Wethersfield loams, and in some of the areas the stones are so abundant as to offer some hindrance to cultivation. In most of the cultivated areas, however, the bulk of the stones has been removed, and in practically none of the areas are they sufficiently numerous to make the types stony loams. The subsoils of the larger proportion of the types are sufficiently heavy to be very retentive of moisture, and crops seldom suffer seriously from drought. They are safe soils, therefore, for the production of such crops as corn, oats, barley, flax, clover, alfalfa, and late potatoes, and are of only slightly less importance for wheat and timothy hay. The loams rank among the most desirable soils of the province for the production of both tree and bush fruits, being particularly adapted to apples, plums, cherries, currants, raspberries, and blackberries, and in a less degree to peaches and pears. They are well adapted to such late vegetables as cabbage, tomatoes, peas, and sweet corn for canning, and to turnips, carrots, rutabagas, sugar beets, and other root crops. In considering the principal special uses to which this group is devoted, it should be noted that a large proportion of the apples grown in northern New York are produced upon the Ontario loam, while the bulk of the potatoes shipped from the famous northern Maine section are grown on the Caribou loam.

Bangor loam.—The type consists of a light grayish brown silty loam from 8 to 10 inches deep, underlain by a yellowish gray or drab loam extending to a depth of 3 feet or more. A shallow phase occurring chiefly at higher elevations and occupying hilltops and slopes has 6 to 10 inches of a brownish-yellow silt loam overlying a somewhat more compact brownish-yellow or drab-gray subsoil of similar texture and with an average depth of less than 3 feet. Both soil and subsoil contain many rounded and subangular granite, quartz, and shale bowlders, stones, and gravel, the proportion of shale fragments being greatest in the shallow phase. The topography is rolling to hilly. The soil is derived from glacial till. The deeper areas are well adapted to the general farm crops, including potatoes, oats, clover, and timothy. The shallower phase has a low agricultural value and a considerable proportion of it is in forest and pasture.

Bernardston loam.—The soil is a light clayey or silty loam of dark color about 10 inches deep, underlain by a dark yellowish loam grading at a depth of 14 inches into a dark slaty blue clay loam of very compact nature. The type occupies broken and hilly areas, occurring largely on drumlinoid hills. The forest is principally hardwood, sugar maple being a prominent species, but in the most stony areas, where the soil is shallow, chestnut, pine, and hemlock are common. The soil is formed from a glacial till, made up of argillaceous rock material. It is very productive, and is well suited to grass. It also produces excellent crops of corn, oats, and rye.

Caribou loam.—The type consists of a hazel-brown silty loam, with an average depth of 10 inches, underlain by a stratum of yellow silty loam, grading at depths ranging from a few inches to 2 feet into the lower till, consisting of a gray or grayish-yellow silty loam. In places this material comes within a few feet of the surface, in which case the yellow stratum is lacking. Small, rounded fragments of sandstone, gneiss, granite, and quartzite are found in both soil and subsoil, but are more numerous in the latter. Almost the entire type is underlain at a depth ranging from a few inches to several feet by a calcareous shale, many small fragments of which are distributed throughout the soil and subsoil. The soil is of glacial origin, the material having been derived largely from the underlying shaly limestone. In virgin forests there is usually a thin layer of white, floury silt just beneath the covering of leafmold. As a rule, the soil is friable, free from large bowlders, well drained, and well suited to cultivation. It is an upland type, occupying swells and ridges and extending down the stream slopes to or nearly to the streams. Drainage is good and the type is retentive of moisture. The native vegetation consists mainly of maple, ash, yellow birch, and beech, with a scattering growth of spruce and fir. This soil is admirably suited to Irish potatoes, grass, oats, and barley.

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Carrington loam.—The soil is a dark-brown to black, mellow loam, ranging in depth from 10 to 14 inches. The subsoil consists of a yellowish-brown, somewhat more compact loam, which at lower depths frequently grades into a heterogeneous stratum of clay, sand, gravel, and bowlders. The type occupies undulating to rolling country. The soil consists of residual material derived from glacial till. While extensive areas are well drained and admirably suited to farming, there are occasional small areas of obstructed drainage embracing bogs, ponds, and swampy depressions, outlets for which in many cases would be very difficult to supply. The type is admirably suited to general farming. Wheat, corn, oats, barley, and flax are the principal crops.

Cazenovia loam.—The soil is a brown loam about 12 inches deep, containing some gravel and fragments of limestone and red sandstone. The subsoil is a brown to reddish clay loam resting on limestone or shale at a depth of 3 feet. Occasionally large bowlders are scattered over the surface. The type occupies high rolling hills and tablelands and is quite uniform in character over large areas. The soil is derived from the weathering of glacial material deposited as terminal or ground moraines. In many instances this mantle is comparatively thin over the underlying limestone and shale, which has contributed considerable material to the drift. The principal crops are grass, alfalfa, corn, potatoes, and wheat, of which good yields are usually secured.

Coloma loam.—This soil is a brown loam 10 inches deep, underlain by a yellowish-brown to yellowish loam, becoming heavier with depth to 18 inches, where it merges into a sticky sandy loam or gravelly loam. It is gently rolling to rolling in topography and is derived from glacial material deposited in the form of moraine. The drainage is good and yields of staple crops, such as corn, oats, rye, hay, and potatoes, are fair.

Culvers loam.—The surface soil is a medium brown loam or heavy loam. The subsoil is of a yellowish-brown color, with a peculiar reddish cast. Subangular fragments of stone, principally from the Medina sandstone and Shawangunk conglomerates, are irregularly scattered throughout the profile, though not to such an extent as to interfere seriously with cultivation. The topography is gently rolling to rolling, and the surface drainage is usually good, though the movement of water through the subsoil is frequently impeded by a compact substratum resembling hardpan. A considerable portion of the type is timbered with oak and chestnut. Cleared areas produce grass, rye, buckwheat, and some corn.

Dover loam.—The soil consists of a light-brown to dark-brown, friable, granular loam or silt loam, about 8 inches deep. The subsoil, to a depth of 36 inches or more, is a yellowish loam or silt loam. Sometimes both soil and subsoil are reddish. Gravel and blocks of limestone are usually strewn upon the surface. The type occurs in valleys and the surface is made up of low hills and ridges and numerous outcropping ledges of limestone. The drainage is good. It is largely residual from underlying limestone, but is partly glacial. The cedar is a characteristic tree growth. This is a strong general farming soil and especially prized for pasture. Corn, oats, wheat, and hay give excellent results, and the type is fairly well adapted to apples and other fruits.

Dutchess loam.—This is a light-brown to brown or grayish-brown rather heavy loam with a slightly lower content of slate and shale particles than is the case with other members of the series. Bowlders are sometimes present and are for the most part derived from local rocks. The subsoil is a light-brown to yellowish-brown loam or silt loam. In some cases a tendency to the formation of hardpan exists. As a rule the soil is friable and easy to work if cultivated under proper moisture conditions. The topography is sloping or rolling to hilly, and surface drainage ordinarily good, though where the subsoil is heavy and impervious the under drainage is frequently inadequate. The type is adapted to general farming, including such crops as wheat, corn, oats, and grass. Clover can be successfully grown when the soil is limed.

Easton loam.—This type consists of an ashy-gray to nearly white silty loam, underlain at a depth of 10 inches by a mottled gray and yellow silty loam, the yellow color becoming more pronounced until at a depth of 36 inches only a slight mottling of gray is discernible. Frequently a layer of sticky yellow clay is encountered at depths of 20 to 30 inches. Usually the soil and subsoil carry a large number of angular glacial bowlders and rock fragments and also considerable small sandstone and shale gravel. When dry the surface has a decided whitish, floury character, due to the presence of glacial ground rock. The type occurs as flat, depressed areas in larger bodies of Caribou loam and as narrow strips bordering areas of muck. In its present condition it is poorly drained and rather difficult to handle. The soil is of glacial origin and owes

its characteristic light color to a less advanced stage of weathering or to an alteration of the upper till through alternating periods of wetness and drought. Where properly drained fair yields of a rather inferior grade of potatoes are secured. Oats and grass do fairly well, but the latter is inclined to winter-kill.

Farmington loam.—The soil is a light-brown silt loam from 6 to 10 inches deep, resting upon thin-bedded shaly limestone. This shallow soil is more or less filled with angular fragments of limestone carrying some glacial gravel and stones. The topography is nearly level and the drainage is good. The type occupies valley positions, where a large part of the glacial material originally present has been swept away by glacial streams, and the soil is thus partly residual. It is well adapted to potatoes, beans, corn, oats, and clover, the success of these crops depending upon the depth to the underlying rock.

Flushing loam.—The soil consists of a friable brown loam from 8 to 14 inches in depth and underlain by a yellow or reddish silty or fine sandy loam extending to a depth of 30 inches, where micaceous yellow sand is usually encountered, though in some cases the material may rest upon crystalline bedrock. The type is developed upon glacial moraines and the intervening depressions between the hills and upon the plains. The material is of glacial origin, mainly from granitic rock, and unmodified by water and wind action. Grass is the principal crop, with corn next in importance. Where not too rough this type makes a strong agricultural soil.

Gloucester loam.—The soil to a depth of 8 inches is a light-brown to medium brown silty loam with a slightly gritty feel, though in some areas the presence of finely divided mica flakes gives the soil a smoother texture. The subsoil is a yellowish, compact silty loam about 30 inches deep, resting upon broken or bed rock. A few rock fragments are strewn upon the surface and through the soil and subsoil. The type occupies the tops and slopes of high ridges and has good surface drainage. It is regarded as cold, wet, late land, owing to the compactness of subsoil, and would be improved by artificial drainage. In origin it is partly glacial and partly residual. It is an excellent soil for timothy, redtop, and clover, and makes good pasturage. In well-drained locations it can be used for orchard sites.

Judson loam.—The soil consists of a mellow black loam, varying in depth from a few inches to 3 or more feet. The subsoil is a yellowish-brown clay loam or unaltered glacial till. The type occurs along the gentle slopes of stream valleys or near the foot of these slopes. It is gently sloping in topography and of colluvial origin. It is admirably suited to fruit culture, especially apples. Only a small part of the type is under cultivation. Good crops of corn, wheat, cabbage, and potatoes are raised.

Kewaunee loam.—The surface soil is a grayish-brown loam about 12 inches deep containing considerable silt and some coarse angular sand and fine gravel. The subsoil is a brownish-red clay loam grading into a light-red clay or silty clay at depths of 24 to 30 inches. This clay is neutral or slightly calcareous in reaction. Throughout the soil and subsoil occur numerous glacial gravels, cobblestones, and bowlders, in some places being so abundant as to preclude boring and to interfere with cultivation. In the region along the western shore of Lake Michigan these are largely of limestone, but include some granite, sandstone, and other rocks brought in from regions farther north. The topography varies from gently undulating to rolling and morainic, the slope being usually sufficient to provide ample surface drainage. In many cases tiling or ditching is advisable on account of the obstruction to moisture movements due to the heavy subsoil. Maple, beech, and hemlock, with some white and Norway pine, constitute the principal native forest growth. The cultivated areas are highly productive, giving good yields of corn, oats, barley, wheat, rye, peas, and hay.

Lackawanna loam.—The surface soil consists of a gray to reddish loam rather high in silt, about 8 inches deep, becoming brown or reddish brown when moist. The subsoil is a reddish-brown or Indian-red loam. Red shale and subangular sandstone fragments of varying size occur scattered throughout the soil profile. The material is derived from the weathering of glacial till, from the red shales of the High Falls formation of Silurian age. The topography varies from undulating to rough and hilly or mountainous, so that the agricultural value is variable. The general farm crops are grown and give fair yields under favorable climatic conditions.

Marshall loam.—The soil is a dark-brown to black loam 10 to 12 inches deep, resting on a lighter colored loam or heavy loam. The deep subsoil consists of a heterogeneous mass of clay, sand, gravel, and bowlders. The type is derived

from unstratified glacial drift. Glacial bowlders are found here and there on the surface, being so plentiful in some areas as to interfere with cultivation. The type occupies gently undulating to rolling country and covers wide areas in the prairies of the Northwest. While extensive areas are well drained and suited to farming, there are numerous bogs, ponds, and swampy depressions, which often present a difficult drainage problem. The soil is excellent for general farming purposes. Wheat, oats, corn, barley, and flax are the principal crops. It is also adapted to vegetables for canning.

Miami loam.—The soil consists of a light-brown to dark-gray, rather mellow loam about 12 inches deep, sometimes becoming lighter in color with depth. The subsoil is a compact yellow or light-brown sandy clay, frequently carrying stones and gravel. Gravelly material is often encountered at a depth of 14 to 25 inches. A few bowlders and pebbles are usually found on the surface. The type occupies level to rolling upland, and is fairly well drained, except some of the level areas. The soil is especially suited to corn and potatoes, while small grains and grass are grown with a fair degree of success. Canning crops and small fruits, such as strawberries and raspberries, do well.

Mohawk loam.—The type consists of a brown to brownish-gray loam about 10 inches deep, underlain by a heavy brown loam extending to 36 inches and becoming heavier with depth. Both soil and subsoil contain some glacial stone and gravel. The topography is usually hilly. The type is derived from the weathering of glacial débris slightly modified by water action over a small part of its area. It is a good soil for corn, oats, and grass, and potatoes give fair results.

Ontario loam.—The soil is a grayish-brown loam about 9 inches deep containing from 20 to 50 per cent of small rounded cobbles and bowlders of crystalline origin. Subangular fragments of shale and limestone are also found mixed with the soil and subsoil over portions of the type. The subsoil is usually a compact brown or reddish-brown loam, often slightly mottled. The topography for the most part is rolling to hilly, especially where it occurs in the drumlin areas of western New York. The type is derived from the weathering of glacial drift. It is usually well drained and the retentive character of the subsoil makes it well adapted to conserve moisture for crops. Good yields of corn, oats, potatoes, and vegetables are secured. It is also well adapted to tree fruits, especially apples and cherries.

Shelby loam.—This type consists of a fine sandy or silty loam of a gray or brown color from 3 to 8 inches deep, grading into a reddish-yellow sandy clay, which extends to a depth of 3 feet or more. It is locally termed "white-oak land." Iron pipes and concretions are usually in evidence. The subsoil is made up mainly of pockets of sand and clay, with occasional thin lenses of cherty gravel. The type is of glacial origin. It occurs topographically below the Putnam silt loam and is exposed through stream cutting and erosion of the overlying prairie. It occupies steep slopes adjacent to the watercourses. The native timber growth consists of white and scrub oak, with a scattering of red oak and hickory. The type is much less productive than the Putnam silt loam. It is poorly adapted to wheat and corn. The former yields an average of about 10 bushels and the latter about 25 bushels per acre. The soil is used almost exclusively for pasture.

Volusia loam.—The surface soil is a light-brown loam about 8 inches deep, containing a considerable quantity of flat shale and sandstone fragments and a large quantity of finely divided shale chips, popularly called "shale gravel" or "black gravel." The subsoil is a yellow or mottled yellow or gray slightly silty loam. Both soil and subsoil contain a large percentage of shale and sandstone fragments. The type is derived through the feeble glaciation of the underlying shales and sandstones. In some places the till is so thin that the underlying shale or sandstone is reached within the 3-foot section. The surface is generally less rolling than that of a greater part of the Volusia silt loam, though for the most part the drainage is adequate. The soil is well adapted to the production of grass, oats, buckwheat, and corn in the less elevated portions. Apples are grown to advantage on this type throughout a considerable part of its extent, and some of the canning crops are also produced.

Wethersfield loam.—The soil is a red or reddish-brown fine sandy loam about 14 inches deep, resting upon a somewhat heavier sandy loam which is light Indian red in color. Both soil and subsoil contain angular bowlders and undecomposed rock fragments, representing from 5 to 50 per cent of the soil mass and varying in diameter from a few inches to several feet. The surface of the type is hilly in some instances, though more often rolling and suitable for

agriculture. The type is derived through glacial action from the Triassic formation. Where the stones are not too numerous or have been removed good crops of heavy-bodied tobacco are produced, as well as corn, wheat, and grass.

Whitman loam.—The soil is a dark-gray, brownish-gray, or black loam about 8 inches deep, underlain by a somewhat heavier gray loam mottled with yellow and brown, the texture usually becoming lighter in the lower part of the 3-foot profile. Granite or gneiss cobbles, stones, and bowlders frequently occur at the surface and in the subsoil. The topography is flat and drainage poor. The type usually occurs associated with areas of Muck or Meadow. White pine, maple, and birch constitute the principal timber growth. When drained the type produces corn, grass, and the heavier truck crops.

Williams loam.—The soil consists of a dark-brown loam or heavy loam about 16 inches deep, the color being due to the presence of organic matter. The subsoil is a whitish, calcareous loam reaching to a depth of more than 3 feet. Both soil and subsoil may contain a small percentage of gravel and bowlders, and in places the subsoil at lower depths passes into a mass of subangular bowlders and clay or loam. It is characteristic of the type that it rarely continues uniform over any extensive stretch of country. The type is of glacial origin and occupies areas of nearly level to rolling topography. The principal crops are wheat and flax and, to a lesser extent, oats, barley, rye, and millet.

Worth loam.—This type is a light-brown loam varying from 6 to 12 inches in depth, underlain by a yellowish-gray loam. Both soil and subsoil contain a rather high percentage of partially rounded glacial stones and gravel as well as local shale from the Lorraine formation. The soil material, however, is comparatively deep to the underlying rock, providing an excellent moisture reservoir. The topography is rolling to hilly, the type ranging in elevation from 700 to 1,700 feet. The surface drainage is ample, while the soil contains enough sand and stone to make underdrainage fairly good. The type is considered well adapted to potatoes, yields of 100 to 200 bushels being secured. Oats, hay, buckwheat, and corn for ensilage are also profitable crops.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Carrington loam	Indiana 6, 7; Iowa 1, 3, 4; Michigan 3; Minnesota 1, 4, 5; Nebraska 3; North Dakota 1, 2, 5, 9; Wisconsin 3, 12, 15.	1,616,768
Shelby loam	Kansas 9; Missouri 1, 2, 12, 13, 16, 17, 19, 20, 21	1,138,944
Volusia loam	New York 1, 6, 9, 13, 15, 18; Ohio 1; Pennsylvania 7	599,650
Ontario loam	New York 1, 8, 10, 13, 15	446,016
Miami loam	Michigan 1, 3; Minnesota 2; Ohio 3, 10; Wisconsin 3, 8, 11, 12, 15.	432,886
Williams loam	North Dakota 11	272,256
Caribou loam	Maine 1	220,672
Flushing loam	New York 7; Rhode Island 1	201,984
Cazenovia loam	New York 9, 14	176,512
Gloucester loam	Connecticut 2; Massachusetts 2; New Jersey 2; New York 4	122,368
Wethersfield loam	Connecticut 1; Massachusetts 1	109,116
Coloma loam	Wisconsin 10, 16	61,056
Dutchess loam	New Jersey 2; New York 5	51,776
Dover loam	New Jersey 2; New York 4	50,112
Kewaunee loam	Minnesota 2; Wisconsin 8	33,408
Bangor loam	Maine 2	32,576
Worth loam	New York 5	24,384
Marshall loam	Illinois 6; Minnesota 5	22,976
Judson loam	Minnesota 1; Missouri 12	17,152
Bernardston loam	Massachusetts 1	16,064
Lackawanna loam	New Jersey 2	12,928
Farmington loam	New York 11, 13	10,560
Easton loam	Maine 1	9,024
Mohawk loam	New York 11	7,680
Whitman loam	Massachusetts 2	4,736
Culvers loam	New Jersey 2	3,328
Total		5,694,932

[1] For key to numbers in this column, see p. 733.

STONY LOAM PHASE.

While areas of this phase occur under conditions of undulating to gently rolling topography, many of them are roughly rolling to hilly and even mountainous, and thus unfavorably situated for successful cultivation. The soils also

contain glacial stones and bowlders of such size and in such quantities that the expense of their removal is not justified by the subsequent value of the land. Where relatively smooth and stone-free areas exist the general grain and hay crops can be produced, though the high altitudes of some of the areas of Dutchess and Volusia stony loams prohibit the growth of any but the earliest maturing varieties of corn. Upon these types, as well as upon the Lackawanna stony loam, buckwheat and potatoes are among the most commonly grown crops, and oats do very well. The phase as a whole is fairly well adapted to grass, especially the Dover, Dutchess, and Volusia types, and where the areas are too rough or stony to permit of profitable harvesting of the crop for hay, the grazing of stock can be successfully engaged in. Where favorable slopes and locations can be secured apples do well, especially upon the Dutchess, Volusia, Hollis, and Gloucester stony loams. The reclamation of the very rough and excessively stony areas of this phase should not be attempted, as they are better reforested or used for pasture lands.

Bangor stony loam.—This type consists of a grayish to yellowish-brown loam to sandy loam 6 or 8 inches deep overlying a somewhat lighter colored and more compact subsoil of similar texture to the soil. The soil section varies from one to several feet in depth over the country rock, and in places there are numerous small areas of rock outcrop. Stones of various kinds and sizes are so numerous as to preclude profitable cultivation, except in small patches. The topography is broken to hilly. The type is devoted almost exclusively to hill pasture and has a low agricultural value. A considerable portion is still forested.

Caribou stony loam.—This soil consists of a yellowish-brown silty loam about 8 inches deep, underlain by a yellowish-gray silty loam which continues to the underlying rock. There are occasional small outcroppings of conglomerates, diabase, andesite, and quartz trachyte, and the slopes are strewn with glacial bowlders of these and similar rocks. On account of the bowlders, the shallowness of the soil, and the steepness of the surface the type is difficult to cultivate. The type occupies high ridges, peaks, and steep slopes. The soil is derived mainly from glacial till, but has in places been materially influenced by the decomposition of the underlying rock or by accumulations of organic matter. The characteristic tree growth consists of yellow birch, beech, and maple, with a sprinkling of spruce and fir. None of the type is under cultivation, and it is best left in forest.

Carrington stony loam.—The soil consists of a dark-brown to black heavy sandy loam from 8 to 10 inches deep. The subsoil is a light-brown or yellow sandy loam to clay loam. A considerable amount of gravel and bowlders is disseminated throughout the soil mass, and bowlders are thickly strewn over the surface. The type occupies rolling uplands and broken slopes. The soil material is derived from glacial till. The abundance of stones makes cultivation difficult over most of the type. Grass does well, and on the whole this soil is best adapted to pasturage.

Cossayuna stony loam.—This type consists of a brown or snuff-colored loam from 8 to 10 inches deep, underlain by a lighter brown loam carrying fragments of shale, calcareous sandstone, and some foreign glacial bowlders. The subsoil usually extends to depths below the 3-foot section, although sometimes the underlying bedrock more closely approaches the surface. The type owes its characteristic brown color and stone content to the weathering of this calcareous sandstone material. It occupies rolling to hilly uplands and is well adapted to corn, oats, potatoes, hay, apples, and other tree fruits.

Culvers stony loam.—The surface soil is a brown to grayish-brown or brownish-drab, friable loam or silty loam, easily cultivated when dry, but inclined to be somewhat sticky when wet. The subsoil varies from a yellow to yellowish-gray mottled silty loam or silty clay loam. Numerous stones and large bowlders of sandstone and conglomerate are scattered thickly over the surface and throughout the soil profile, rendering the type for the most part nonarable. It is locally known as "gray-rock land." The topography is gently rolling to hilly. Good grass sods form, and the type is best adapted to pasturage.

Dover stony loam.—The surface soil of this type is a light-brown to yellowish-brown loam or silt loam about 7 inches deep. The subsoil is a yellowish-brown, heavier silt loam containing some of the finer grades of sand. Stones and bowlders of limestone, together with some crystalline bowlders of glacial origin, are also present in the soil profile. Outcrops of limestone rock are of frequent occurrence. The topography ranges from gently undulating to rolling, with ridges in the valleys where the limestone ledges occur. The rough topography

and the abundance of rock fragments and outcrops preclude any attempt at cultivation. The type furnishes excellent pasturage, however, as bluegrass grows well.

Dutchess stony loam.—The soil consists of a light-brown friable and somewhat granular loam or silt loam, about 8 inches deep, underlain to a depth of 18 inches by a yellowish or reddish-yellow material, similar in texture to the soil, though varying somewhat in content of sand and clay. The type occupies low hills and ridges and rocky, irregular knolls with small swampy intervening depressions. The underlying rock is often exposed. Drainage is generally good. The soil is of glacial origin, but the underlying rock is so near the surface that it has influenced the character of the soil somewhat. The forest growth consists of oak, chestnut, maple, and cedar. The type is not generally considered good farming land, though in places it is excellent for apples or pasture. Where so used organic matter should be supplied. Some areas should be left in forest.

Gloucester stony loam.—The soil is a light-brown sandy loam underlain at a depth of 10 inches by a more sandy and gravelly material of gray color. The subsoil is a mass of rock fragments, the thin soil mantle often resting directly upon the bedrock. From 20 to 80 per cent of the bowlders occur on the surface and throughout the soil profile, while frequently the bedrock is exposed. The type usually presents a rough, broken topography, hilly and almost mountainous in character, and on account of its position and the loose, open character of the subsoil it is in many places excessively drained. The soil is in part residual and in part of glacial origin, bearing, however, a distinct relation to the underlying or adjacent rock, from which, in the main, it has been derived. Very little of this type is cleared and under cultivation, and it is covered for the most part with a stunted growth of chestnut, oak, white birch, and undergrowth. Some corn and potatoes are produced, but only light yields are obtained. The type as a whole is best suited to forestry and pasturage, though in some places orcharding should be profitable.

Hollis stony loam.—This soil to a depth of 6 to 8 inches is a light-brown fine loam, silty and somewhat sandy. The subsoil is a light-yellow or grayish heavy loam to sandy loam. Both soil and subsoil are filled with slaty fragments of schistose rock. Occasionally there is considerable mica in both surface and subsoil. The type ranges in elevation from 200 to 500 feet, the surface consisting of a series of low knolls and ridges. It is in part derived from overlying glacial material and in part from the weathering of the underlying micaceous schistose rock. Fair yields of corn, oats, and grass are secured. Apples are the principal fruit crop, although strawberries and other small fruits do well and there are some successful peach orchards on the type. Dairying is the principal farming industry. Organic manures are necessary to maintain the productivity of the type.

Holyoke stony loam.—The soil consists of a yellow or brown loam from 7 to 12 inches deep, overlying a loam or heavy sandy loam subsoil to the depth of about 3 feet. Numerous stones and bowlders of diabase and other crystalline rocks, together with some gravel, are found throughout the soil section. The material is of glacial origin. The areas are rough and mountainous, occurring along the lower slopes of diabase ranges. Where not too rough and stony the soil is used for grass and grain crops and to some extent for tobacco. Dairying is the most important industry, though the type is quite extensively used for fruit, especially apples.

Kewaunee stony loam.—The soil to a depth of 12 inches consists of a light-brown loam, underlain by a loam grading into red clay at depths of 22 to 36 inches. On the surface and mixed with the soil are stones and bowlders in considerable quantity. The surface is rolling to hilly, and the natural drainage is generally good. It is a glacial soil, and where not too rough or the stones too numerous is adapted to oats, hay, and wheat.

Lackawanna stony loam.—The soil is a reddish-brown loam about 7 inches deep, underlain by a reddish to Indian-red loam. A large percentage of subangular fragments of red sandstone and shale occur throughout the section. The topography varies from rolling to hilly and mountainous, and drainage is good to excessive. On account of the high stone content, combined with the rough topography, much of the type is valuable only for pasturage and forestry. Chestnut and oak are the prevailing native varieties of trees growing on the type.

Nunda stony loam.—The soil consists of 6 inches of light-brown heavy loam, carrying a generous content of rounded glacial stones and gravel. The subsoil

is a brown to bluish glacial till, also filled with rounded limestone fragments and other glacial materials. The type is of till origin. It has a small total area and is not farmed extensively.

Ontario stony loam.—The soil is a light-brown friable loam, with a subsoil of about the same color and texture as the soil, but slightly more compact. Both soil and subsoil contain numerous subangular glacial stones and bowlders of limestone, together with some foreign rocks. These are so numerous as to seriously interfere with cultivation. The topography is rolling to hilly, some of the type occurring on steep slopes. Drainage is usually good. The native forest growth is principally hard maple, together with some beech, birch, elm, etc. The type is principally in forest. Where not too rough and stony cleared areas are quite productive of the ordinary farm crops.

Shelby stony loam.—This type comprises outcrops of the Kansan till, too rough and stony for cultivation, and used mainly for pasturage. The areas occur associated with other members of the Shelby series and probably will be mapped only in areas where the Kansan till or other older glacial till is represented. The type differs from the Miami stony loam in being noncalcareous, while the interstitial material is much heavier and more impervious than that of the Coloma stony loam of the Wisconsin drift. The type is found principally along the margins of valleys and is subject to considerable erosion.

Volusia stony loam.—The soil to an average depth of 9 inches is a brown, rather heavy loam. The subsoil consists of a yellow or mottled yellow and gray loam, which becomes more sandy with increasing depth and continues to 3 feet or more. Both soil and subsoil are filled with flat shale and sandstone fragments. The type is derived from the wash of higher lying areas of Volusia loam or Volusia silt loam deposited over moraine belts bordering the higher uplands. It is a good general-purpose farming soil, and where well drained is adapted to apple orcharding. It also produces good yields of timothy hay, oats, buckwheat, and potatoes.

Wallpack stony loam.—The soil is a light-brown to yellowish-gray loam about 7 inches deep, overlying a yellowish-brown to yellow loam of similar texture. The type occupies steep slopes, and both soil and subsoil contain numerous loose rock fragments, stones, and bowlders of chert, limestone, and shale. Drainage is ample. The rough topography and high stone content restrict the use of the type to pasturage and forestry. The natural timber growth consists of oak and chestnut, together with occasional dogwood and cedar trees.

Williams stony loam.—The soil is a brown or dark-brown loam, usually underlain by a gray or yellowish-gray, heavier textured, calcareous subsoil. The type occupies semiarid upland areas that are so covered with bowlders that cultivation is difficult and sometimes impossible. The stone content in such localities may range from 15 to 50 per cent of the soil mass to a depth of 3 feet. The stone may range in size from gravel to bowlders weighing many hundred pounds, but the large bowlders are rare. The type has a roughly rolling topography and is of glacial origin. It constitutes a valuable pasture land.

Worth stony loam.—The soil is a brown to grayish-brown loam or fine sandy loam about 6 inches deep, underlain by a heavier loam subsoil of light brown or grayish color. A rather large percentage of foreign bowlders and large stones occur at the surface and throughout the profile, and mixed with this is some local shale rock. The type is developed on hilltops, steep slopes, and to some extent in valley positions. The areas are for the most part timbered with maple, elm, beech, and birch. The type has a low agricultural value on account of its stoniness and rough topography, though it affords considerable pasturage. It should be forested rather than cultivated.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Holyoke stony loam	Connecticut 1; Massachusetts 1	196,818
Gloucester stony loam	Massachusetts 2; New Hampshire 1, 2; New Jersey 2; New York 4.	141,632
Dutchess stony loam	New Jersey 2; New York 4, 17	130,048
Cossayuna stony loam	New York 17	88,448
Carrington stony loam	North Dakota 2, 5, 8; South Dakota 2	84,096
Williams stony loam	North Dakota 11	69,888
Bangor stony loam	Maine 2	29,248
Culvers stony loam	New Jersey 2	23,360
Dover stony loam	do	21,632
Lackawanna stony loam	do	18,624
Volusia stony loam	New York 15; Pennsylvania 7	13,184
Kewaunee stony loam	Minnesota 2	8,704
Hollis stony loam	New Hampshire 2	7,040
Ontario stony loam	New York 5, 14	3,904
Caribou stony loam	Maine 1	3,328
Wallpack stony loam	New Jersey 2	1,664
Worth stony loam	New York 5	1,344
Shelby stony loam	Kansas 9	832
Nunda stony loam	New York 6	320
Total		844,114

[1] For key to numbers in this column see p. 733.

SHALE LOAM PHASE.

This phase, like the stony loam phase, is characterized by a rolling to hilly topography, in many places so steep as to render cultivation impossible. The stone content is fully as great as in the case of the stony loams, but consists to a large extent of local material from the underlying shale formations. This is ordinarily very angular and usually platy in form, while the stones and bowlders found in the stony loams are more rounded in outline and consist for the most part of thicker-bedded, harder rock fragments of granite, gneiss, sandstone, quartzite, trap rock, and limestone, many of which have been transported long distances. The fine earth texture of the shale loam phase, too, is more usually a silty loam or silt loam, being formed from the disintegration of the finer-textured shale rock. This slightly heavier texture makes the shale loams somewhat better adapted to grass and the small grains, though the soils are not infrequently so thin and shallow as to be more droughty than the deeper stony loams. Favorably situated and not too shaly areas of the shale loam phase produce fair yields of corn, rye, oats, buckwheat, and timothy. Some fruit, especially grapes, is grown on the Volusia and Dutchess types.

Dutchess shale loam.—The soil of this type is a light-brown to grayish-brown silty loam or silt loam, ranging from 4 to 8 inches in depth. From 40 to 75 per cent of angular shaly and slaty rock material is usually present. In some places where the extent of weathering has been greatest the soil is gravelly. The subsoil is a grayish-brown to grayish-yellow silt loam of a smooth, velvety feel, carrying broken fragments of shale and slate, the content increasing as bedrock is approached. The type occupies rolling to hilly topography. In many places the surface drainage is excessive, though where the underlying rock approaches the surface the subsoil is apt to be poorly drained during seasons of normal precipitation. The native forest growth usually includes considerable oak and chestnut. On account of the many steep areas and the tendency to droughtiness the agricultural value of the type is low compared with other members of the series. Corn, buckwheat, and the small grains are grown, together with some fruit.

Volusia shale loam.—The Volusia shale loam occurs upon steep slopes leading down to the old glacial lake basins or along narrow V-shaped valleys, where there has been either very little glacial material deposited by the ice or where such deposits have been to a large extent subsequently removed by erosion. The resulting soil material consists, therefore, partly of glacial soil and heterogeneous rock material brought in by the ice and partly of residual material from the underlying shales. Considerable colluvial action has also taken place along these steep slopes, which has assisted in mixing the glacial and residual material. The soil is thin and shaly and of low agricultural value, except for

some special crops such as grapes. Areas of this type are always closely associated with some other member of the Volusia series.

Wallpack shale loam.—The soil is a light, ashy-gray silt loam, containing a high percentage of small shale fragments. The subsoil is a pale-yellow or yellowish-gray silt loam, containing a rather higher percentage of shale than is present in the soil. The soil is uniformly shallow, the underlying rock being found at a depth of 22 to 36 inches. The soil is considerably influenced by the intermixture of residual material from the Oriskany sandstone and Esopus slate. The topography is rolling and natural drainage good. The type occurs on top of Wallpack Ridge, on the western side of Kittatinny Mountain, in New Jersey. On account of the rough, broken topography and high content of shale its agricultural value is low. Such areas as can be cultivated produce fair yields of corn and rye.

Area and distribution of the shale loams.

Soil name.	State or area.[1]	Acres.
Dutchess shale loam	New Jersey 2	54,272
Volusia shale loam	New York 6, 13, 18	44,388
Wallpack shale loam	New Jersey 2	2,176
Total		100,836

[1] For key to numbers in this column see p. 733.

SLATE LOAM PHASE.

The general characteristics of this phase are much the same as those of the shale loam, the principal difference consisting in the size and thickness of the rock fragments which occur on the surface, and are mixed with the soil and subsoil. In the case of this phase the fragments are usually small and thin, offering less hindrance to cultivation than the fragments from thicker bedded shales. As a whole the soil of the slate loam phase is shallower than that of the shale loam phase. It contains more residual material from the underlying rock, is less extensively modified by glacial action, and by the intermixture of foreign stones and bowlders of crystalline or other rock material. The shallow soil mantle makes the slate loams droughty as a rule, and not well adapted to corn or crops requiring a long season in which to mature. Such cereals as rye and oats do well on areas which can be cultivated. The phase is best adapted to grass and buckwheat. Apples also do well where care is used in selecting orchard sites. Some of the rougher areas should be reforested.

Dutchess slate loam.—The soil is a light-brown, fine, silty shale, or slate loam, 6 or 8 inches deep, often quite gritty, and underlain by a lighter colored or yellowish material, extending to a depth of 24 inches, and similar in texture to the soil. Rock fragments and outcrops are common. The type occupies hills and ridges of varying heights, with swampy intervening depressions. Surface drainage is usually good, and areas on the hills and ridges are often droughty. It is glacial in origin, but the underlying rock is so near the surface that it has influenced the character of the soil to some extent. Much of the type is still forested with chestnut, oak, and cedar. It is considered a light, thin land, and requires constant fertilization. It makes fair soil for grass, pasture, and buckwheat. All general farm crops are grown to some extent.

Area and distribution of the slate loam.

Soil name.	State or area.[1]	Acres.
Dutchess slate loam	New York 4, 17	138,624

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase is more easily cultivated than the stony, shale, and slate loam phases, on account of the smaller size of the rock fragments mixed with the fine earth or soil proper. The topography varies from undulating or gently rolling to hilly in places. Upon some of the steeper slopes the free surface drainage combined with the somewhat porous subsoil causes crops to suffer from lack of moisture. On the few level areas, however, the presence of the gravel in the subsoil is often beneficial and assists the downward seepage of surplus surface waters. Corn, rye, oats, grass, and potatoes are productive crops on this phase, yields depending upon the surface configuration of the land and the drainage.

Caribou gravelly loam.—The soil consists of a gravelly loam high in silt and varying in color from yellowish brown to dark chocolate brown. At a depth of 10 inches the soil grades into a bright-yellow gravelly loam, with a higher content of gravel, which at about 20 inches passes into a dark-colored coarse gravel or compact yellowish-gray gravelly loam. Both soil and subsoil carry from 40 to 50 per cent of rounded and angular glacial gravel varying from one-fourth of an inch to 4 inches in diameter. The type is of glacial origin and occurs on knolls and along stream slopes. Drainage is good. It is well adapted to potatoes, grass, and buckwheat. Oats do fairly well.

Carrington gravelly loam.—The soil consists of a dark-brown light sandy loam to heavy sandy loam carrying a considerable amount of small gravel. The subsoil is a yellowish gravelly sandy loam to clay loam. In the vicinity of streams where erosion has been active a number of variations from the typical soil are encountered, among others areas of gravelly clay which are difficult to cultivate. The topography is rolling to hilly and the surface often badly dissected. The soil is derived from glacial till. Some areas have a sufficiently favorable surface configuration to be used for crops, but much of the type is too rough for cultivation and should be devoted to pasturage or timber. Corn and wheat do well on the gently rolling areas.

Kewaunee gravelly loam.—The soil of the Kewaunee gravelly loam is gray to brown in color. The subsoil is gray to brown in color. The soil, to an average depth of about 19 inches, is a heavy sandy loam to clay loam with small amounts of medium to coarse gravel. The subsoil consists of a bed of gravel with interbedded sand layers. The gravel varies from fine to coarse and includes some large cobbles. There is a substratum of red clay which may occasionally rise into the 3-foot section. It may lie 20 feet or more below the surface. The topography is undulating to rolling, usually occurring as a low ridge. The material was deposited as a beach ridge. It is a droughty soil.

Mapleton gravelly loam.—The soil is a purplish-red, rather coarse gravelly loam of varying depth up to 12 inches. Bedrock may be encountered at depths of 6 to 20 inches and occasionally outcrops in small areas. Where the depth of soil exceeds 12 inches a reddish-yellow gravelly loam is found between it and bedrock. The gravelly material consists of angular and water-worn fragments of sandstone and quartz. The type occupies ridges and slopes and is well drained. The soil is partly glacial and partly residual, being influenced by the underlying red conglomerate and sandstone. Potatoes, grass, and grain do well where the rock does not lie too near the surface. Apples give good results when care is used in selecting orchard sites.

Miami gravelly loam.—The soil to a depth of 6 to 8 inches consists of a brown silty loam carrying a small amount of gravel. The subsoil is a light-brown to brown clay loam containing more gravel than the surface soil. At a depth of 2 to 3 feet gravel beds are often encountered. The type occupies the crests of upland ridges. It is residual and derived from glacial till. General farm crops are grown, but the yields are rather low, especially in dry years.

Ontario gravelly loam.—This type consists of a brown gravelly loam about 8 inches in depth, underlain by a subsoil somewhat lighter in color but otherwise of the same character as the soil. Both the soil and subsoil contain varying quantities of gravel, chiefly subangular, and varying in size from fine gravel to cobbles. This gravel is chiefly limestone with some foreign crystalline material. The topography varies from gently undulating to rolling and surface drainage is usually fair. Good natural underdrainage is ordinarily secured through the presence of the gravel. It is a valuable agricultural type, especially adapted to corn, potatoes, and beans. Grass also does well.

Rodman gravelly loam.—The surface soil consists of a light-brown, mellow silty loam about 10 inches deep, with a varying content of coarse and fine sand and large quantities of rounded and subangular gravel. The subsoil is a light-brown or yellowish-brown gravelly and sandy material, the gravel and stone content consisting of foreign glacial erratics and limestone of local origin. The type occurs as eskers and kames, and the topography is broken, ridgy, and hummocky. Natural drainage varies from good to excessive. The land is generally too rough for general farming, although some areas produce profitable crops. For the most part, however, it is used for pasture.

Volusia gravelly loam.—The soil, to an average depth of 6 inches, consists of a light-brown to ash-colored loam, containing a large quantity of broken shale and sandstone fragments and a considerable proportion of small shale chips, besides some round gravel and cobblestones. The subsoil varies from a yellow loam to a yellow or gray sandy loam. The type is derived from the material of small moraines scattered through the Volusia loam or Volusia silt loam areas. It occurs in the high valleys of the region in which the Volusia series is found. Corn, oats, rye, and potatoes do well where the soil is not droughty or too gravelly.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Carrington gravelly loam	Kansas 2; Minnesota 4; North Dakota 2, 4, 8; Wisconsin 4	81,984
Volusia gravelly loam	New York 6, 13, 15; Pennsylvania 4, 7	45,760
Miami gravelly loam	Ohio 2; Wisconsin 4	45,376
Rodman gravelly loam	New York 5; Pennsylvania 4; Wisconsin 8	11,008
Ontario gravelly loam	New York 13	4,992
Caribou gravelly loam	Maine 1	3,904
Kewaunee gravelly loam	Wisconsin 4	1,280
Mapleton gravelly loam	Maine 1	192
Total		194,496

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loam soils have by far the largest areal development of any group in this soil province, and, with the exception of the fine sandy loam group of the Atlantic and Gulf Coastal Plain province, the largest of any agricultural soil in the United States. Upon these soils is grown the bulk of the great staple crops of the United States. They furnish the greater proportion of the cereals directly produced for local consumption and export, as well as the hay and grain used in the production of beef and other meat supplies. Dairying is also an important industry on these soils. The topography in the main is gently undulating to smoothly rolling, interrupted in places by nearly level areas situated on the tops of drainage divides. The surface slopes are favorable for the use of all kinds of farm machinery, and the uniformity in texture and distribution in large bodies makes the production of the staple cereals more economical than upon soils of other groups which are usually developed in smaller areas. Some of the types, however, notably the Memphis silt loam, are quite rolling to rough in topography, and erosion is frequently so severe as to interfere with cultivation and result in many areas of waste land. Artificial drainage is often necessary on some areas of such types as the Putnam, Marion, and Volusia silt loam, on account of the lack of surface slope and the relatively impervious subsoils. Taken as a whole the surface drainage of the group is adequate, but an intelligently constructed system of underdrainage in nearly all cases results in increased crop returns and is a profitable investment. The soils of the silt loam group are relatively friable and easily cultivated, and under favorable moisture conditions it is possible to secure a mellow seed bed. The subsoils are dense and heavy enough to maintain a good supply of soil moisture for use during the slow growth and maturity of the cereal crops.

The Marshall silt loam is the principal corn soil of the United States, and only slightly less important for wheat. Buckwheat and late potatoes are among the principal crops produced on the Volusia and Lackawanna and some of the other glacial silt loams of the Allegheny Plateau region, where the elevation is rather

too great for the successful production of corn for grain. Fruit, especially apples, is grown to some extent on some of these plateau soils.

Between these northern glacial soils and the southern extension of those derived from the loessial deposits there is a wide range in latitude, some of the loessial soils occurring as far south as Baton Rouge, La. Upon these southern loessial silt loams—the Memphis, Richland, Lexington, Carroll, and Safford—corn and cotton are the principal staple crops, while some tobacco is grown. Sweet potatoes rank high among the garden crops, and sugar cane is grown to a small extent for home consumption.

The silt loams of this province are, as a whole, well adapted to many of the late vegetables for winter supplies and for canning purposes. The vegetables, such as cabbage and the root crops, are firmer in texture than those grown on lighter soils and possess good keeping qualities.

Caribou silt loam.—The soil consists of a yellowish-brown to hazel-brown silt loam about 10 inches deep. The subsoil is a brighter yellow silty loam, sometimes continuing throughout the soil profile or frequently grading with depth into the grayish silty loam of the lower till. Calcareous shale is encountered at depths varying from 1 to several feet. There are many small shale fragments and a few small bowlders throughout the soil section. The type contains fewer stones than the loam member of the series. It occupies ridges, slopes, and flat areas and has good drainage. This soil consists of weathered glacial material derived largely from the underlying limestone or calcareous shale. It is well adapted to Irish potatoes, grass, and grain. Fruit and vegetables do fairly well.

Carrington silt loam.—The soil consists of a dark-brown to black silt loam having an average depth of about 12 inches. The subsoil is a yellowish-brown to pale yellow silty clay loam or silty clay. The topography is mainly level to undulating. The soil represents a residual stratum derived from glacial till. The type is admirably adapted to the general farm crops, including wheat, corn, oats, barley, rye, flax, and grass.

Carroll silt loam.—The soil of this type is a light-gray silt loam 8 or 10 inches deep, underlain by a compact, impervious, heavier subsoil of slightly darker color, which is more or less mottled with yellow and brown iron stains. Numerous iron concretions are sometimes found in the subsoil, with marked traces of acidity. The type occurs in a broad, flat belt contiguous to the Memphis silt loam and as narrow strips of "slash land" within the latter type. The drainage is naturally poor and during the winter and spring months much of the land is covered by a shallow sheet of water. The type represents deposits of loess which have been subjected to very poor drainage conditions. It contains little organic matter and not much of it is in cultivation, being covered with a heavy growth of oak and an undergrowth of palmetto. Its best use is probably for forestry, although it can possibly be reclaimed at considerable expense and made a good rice soil.

Dutchess silt loam.—The type consists of a light-brown friable loam 8 to 10 inches deep, underlain by a rather compact, impervious silt loam, the color of which grades from light brown to yellowish. Below 36 inches the color often changes to drab and blue. Usually there is an abundance of rounded rocks on the surface and throughout the soil section. The material is derived principally from the glacial mantle, influenced in places by the proximity of the underlying rocks. It forms the surface of rounded drumlinoid hills and ridges which have only fair drainage. The soil as a rule is cold, wet, and late, and is improved by tile drainage. Where drained it is a good general farming soil and well adapted to grass, hay, pasture, and ensilage corn. Wheat, rye, oats, and potatoes give fair results. Apples, peaches, and plums do well.

Farmington silt loam.—The soil is a mellow, brown to dark-brown silt loam about 12 inches deep. The subsoil is a brown to light-brown silt loam. Angular fragments of limestone are occasionally found in the soil and subsoil of some areas of the type. The underlying limestone is usually encountered at depths of 3 to 5 feet. The rock is often shattered, however, so that free underdrainage is secured and favorable moisture conditions maintained. The type generally occupies broad, level areas. The original native timber growth consisted of beech, maple, and other hardwoods. The type is highly esteemed for the production of general farm crops, giving excellent yields of corn, grain, and grass. Beets are grown to a considerable extent for cattle feeding.

Upon slopes and rock escarpments a shallow phase of the type is occasionally encountered. Cultivation in such situations is sometimes more difficult, owing to the topography and higher content of loose limestone fragments. Practically the same system of agriculture is practiced, and the same crops grown.

Hamburg silt loam.—The soil is a grayish-yellow to light-brown, fine, floury silt of loose structure, underlain by a subsoil possessing practically the same characteristics, though sometimes mottled and containing iron and lime concretions and pipes. The material is subject to more or less drifting by the winds. While essentially loose in structure, the undisturbed deposits are remarkable for their ability to maintain vertical exposures along the bluff lines. The type represents the material forming the immediate loess bluffs from a few rods to half a mile or so in width, along some of the larger rivers of the Central West. These loess deposits range from a few to 200 feet or more in depth. The topography is generally so rough as to preclude agricultural operations. While generally found under prairie conditions the type is sometimes forested. On account of its unfavorable topographic position it is of little agricultural value.

Judson silt loam.—The type consists of a dark grayish brown silt loam of somewhat variable depth, but averaging about 20 inches, underlain by a similar textured, lighter colored subsoil. It occurs as a strip of varying width at the upper side of the stream bottoms along some of the larger rivers in the Glacial and Loessial region. The soil is of colluvial origin, being formed largely by the talus which has moved downward from the bluffs. It lies above overflow, and is a very productive type, well adapted to corn, wheat, and alfalfa.

Knox silt loam.—The soil is a yellowish-brown, light-brown silt, or buff-colored loam, having an average depth of 10 inches. The subsoil is a compact, light-brown to pale-yellow silt loam to silty clay. It occupies rolling to hilly areas, which originally supported a hardwood timber growth. The soil is the result of wind-deposited glacial material. The type produces good yields of wheat, corn, clover, and grass. Certain fruits and vegetables, such as Irish potatoes, give profitable returns.

Lackawanna silt loam.—The soil of this type is a peculiar dark Indian-red or sometimes pinkish-red silt loam to the depth of 8 inches or more where it is underlain by a silt loam of the same color or sometimes slightly lighter. The quantity of shale and sandstone chips occurring in this soil varies, but is often large. The topography is rolling to hilly, much of the type occupying rather plateaulike hills with smoothly rounded tops and steep sides. The surface drainage is good, though sometimes artificial means are necessary to perfect the underdrainage. This is a good general farming soil, producing fair yields of corn, wheat, buckwheat, and grass. In localities where the type is associated with the Volusia silt loam it is considered superior to that soil on account of its rather better drainage and the possibility of cultivating it somewhat earlier in the spring.

Lexington silt loam.—The soil to a depth of 12 inches is a gray or yellowish-gray, mellow silt loam. The subsoil to a depth of 36 inches is either a compact silt loam, slightly heavier than the soil, or a silty clay varying from yellow to brown in color or sometimes tinged with red. The surface is moderately rolling to hilly, the rougher portion being largely the result of erosion. The drainage is thorough and crops suffer for lack of water during extended droughts. The type is derived from loess and closely resembles the Memphis silt loam; but the deposit of loess is very thin and the soil is in places modified by the underlying Orange sand formation. The soil is adapted to corn, cotton, forage crops, vegetables, and strawberries. The natural forest growth consists of white, red, post, and blackjack oak, chestnut, hickory, and black gum.

Marion silt loam.—The soil consists of a light-brown to white silt loam, about 12 inches deep. The subsoil is a stiff, mottled silty clay, locally known as "hardpan," the predominating colors being gray, light yellow, and reddish yellow. Between the soil and subsoil occurs a white layer of compact silt, which crumbles easily between the fingers. This silty layer, together with the impervious subsoil, interferes with the absorption of surface water, making the type somewhat droughty. The type occupies level prairie land and is of loessial origin. Wheat, corn, and grass are the principal crops, the type being better adapted to wheat than to corn. The yield of grain is rather small. Apples do well in favorable seasons.

Marshall silt loam.—The soil is a dark-brown to black silt loam, 15 inches deep, resting usually upon a light colored, sometimes mottled, silty loam or silty clay. Lime concretions occur in a few instances in the western extension of the type. The topography varies from level to rolling and hilly. The soil is derived from loessial deposits. Drainage is generally good but not excessive, the subsoil retaining moisture well and crops resisting drought to a marked

degree. This is a fine soil for the production of wheat, corn, oats, alfalfa, tobacco, and sugar beets where climatic conditions are favorable. It is the most important corn soil in the United States. Vegetables for the fall and winter markets do well under favorable climatic and moisture conditions.

Memphis silt loam.—The soil is a yellow or brown silt loam 8 inches in depth and powdery when dry. Beneath this is a yellowish-brown to reddish-yellow or buff compact heavy silt loam or silty clay loam. The type occupies uplands and is subject to serious erosion. It is largely forested to oak, hickory, and beech. In Mississippi it is divided topographically into two regions—the Cane Hills, which are steep-sided and narrow-topped, and the Flat Hills, which are more plateau-like and cultivated to a greater extent than the Cane Hills. Good yields of cotton, corn, wheat, oats, hay, and potatoes are secured in different localities. In northern areas the soil produces good yields of fruits and vegetables.

Miami silt loam.—This is a light-brown, yellowish-brown or grayish silt loam, from 8 to 12 inches deep, underlain by a compact, yellowish or brownish mottled silt loam or silty clay. The type occupies rolling to hilly areas and was originally timbered. It is the result of the weathering of glacial till, with the admixture in places of small amounts of loessial material. It is not as productive as the Marshall silt loam, but produces good yields of wheat, corn, clover, and timothy hay. Fruits do well in some locations.

Mohawk silt loam.—The surface soil consists of a light-brown silt loam, about 8 inches deep. It is underlain by a heavy silt loam grading with depth into a clay loam and frequently mottled with yellow, brown, and gray, in the lower part of the 3-foot section. The topography is rolling to hilly. Surface drainage is usually good, but the underdrainage is frequently poor, on account of the heavy, compact subsoil. This type is derived from a thin mantle of glacial till. It is a general farming soil producing moderate yields of corn, oats, grass, hops, and wheat. Carefully selected sites give good crops of apples. It is best adapted to dairying.

Ontario silt loam.—The soil is a brown to grayish silt loam 8 to 12 inches deep. It is, as a rule, friable and easily tilled, especially when it contains a small percentage of gravel, small stones, and bowlders, as is usually the case. In depressions and flat areas where the fine material has been accumulated and the drainage is poor it is inclined to bake. The subsoil consists of a yellowish to grayish silt loam, passing sometimes into a mottled reddish, yellowish, and gray silty clay. The soil is derived from glacial till consisting largely of weathered local shale and limestone rock modified by some foreign glacial material. In most of the areas there are usually a great many limestone fragments in both soil and subsoil. The topography is rolling to gently undulating, being that of a till surface. Wheat, corn, beans, oats, and hay are grown.

Portage silt loam.—The type consists of a grayish-colored silt loam 8 or 10 inches deep, underlain by a mottled gray and yellow heavy clay loam. At a depth of 25 inches or more a thin stratum of sand, sandy loam, or sandy clay is often encountered which grades abruptly into a dark-red clay. The type occupies level or slightly undulating areas, is rather poorly drained, and sometimes marshy. The surface soil is derived from glacial material, while the subsoil is to a large extent residual from the underlying crystalline rocks. It is well adapted to general farm crops, small fruits, and vegetables.

Putnam silt loam.—The soil is a dark-gray to nearly black silt loam from 6 to 10 inches deep, underlain by a stiff, impervious, brown or drab mottled silty clay, streaked with blue and red. A thin layer of white silt is often found between soil and subsoil. This type resembles both the Marshall and Marion silt loams. It differs from the former in having a heavy, impervious subsoil and from the latter in the darker color of the surface soil. It is derived from a deposit of loess over glacial material. The type is known locally as "the prairie" and occupies level to gently rolling uplands. The greater part is fairly well drained, but the impervious subsoil allows water to collect on level areas after heavy rains. The principal crops are hay, corn, oats, and wheat, with millet, kafir, and sorghum as secondary crops. Fruit also does well, apples being a crop of some importance.

Richland silt loam.—The surface soil to an average depth of 12 inches consists of a brown or light-brown silt loam. The subsoil is a reddish-yellow to buff silty clay loam or heavy silt loam, more compact than the surface soil. This material in turn is underlain by a considerable thickness of yellow silt or material of the loess formation. The type occurs on the uplands in the "flat hill" portion of the loess area. Natural drainage is good. Some of the fields

are badly washed, but the type is nowhere so deeply eroded as the Memphis silt loam. It gives fair yields of cotton and corn and in some localities is also used for the production of strawberries, cabbage, Irish potatoes, and other truck and fruit crops. It is distinguished from the Memphis silt loam by more level topography, less active erosion, and uniform existence of the complete soil and subsoil section underlain by the loess. It will be found throughout the "flat hill" region of the loess-covered uplands adjacent to the Mississippi River and its tributaries south of the Ohio River.

Safford silt loam.—The soil consists of a gray to light-yellow silt loam from 8 to 10 inches deep. This is underlain by a tough plastic clay or clay loam of a red or reddish-brown color, grading at 3 feet or more into greensand. The surface soil is loose and rather incoherent when dry, and is easily cultivated. The topography is rolling to hilly and unless carefully handled the soil washes badly. Natural drainage is good. The silt loam covering is due to a deposit of loess, while the subsoil is derived from the weathering of the greensand marl or a shallow deposit of clayey material above it, or from a mixture of both. The soil is adapted to corn, cotton, wheat, hay, truck crops, and melons. The timber growth consists of white, red, blackjack, and post oak, chestnut, and some hickory and beech.

Scottsburg silt loam.—This soil is an ashy-gray silt loam, grading at a depth of 10 inches into a light-yellow or slightly mottled silt loam which becomes gradually heavier and more compact with depth until at 30 to 36 inches a heavy silt loam of drab to gray color, slightly mottled with yellow stains, is encountered. Small iron concretions occur throughout the entire soil section. The type is formed from local material, redeposited by glacial action, and mixed with the weathered product of the underlying argillaceous and sandy shales. The areas were probably at one time level, but have been eroded by stream action until they present a gently rolling topography. The soil is best adapted to tomatoes and other vegetables, fruits, and all early maturing crops. By adding humus and adopting an intelligent system of crop rotation the general crops may be made to do well.

Union silt loam.—The soil consists of a grayish-brown to brown, smooth, friable silt loam, the color changing at an average depth of 8 to 10 inches into a light brown or yellowish brown. The subsoil consists of a yellowish-brown to chocolate-brown heavy silt loam to silty clay loam, which in turn passes at a depth of 20 to 26 inches into a friable or brittle yellowish or chocolate brown, heavy silty clay loam to silty clay, often mottled with gray. Reddish and brownish iron-oxide stains and iron concretions are sometimes seen in the subsoil, particularly in the flat areas, while over the level and poorly drained areas the soil shows a more grayish cast. Owing to erosion, the heavy subsoil occurs near the surface on many of the slopes. The topography varies from gently rolling to hilly, the slopes being usually smooth and gentle, so that a large proportion of the type is well suited to cultivation. The origin of this soil is not perfectly clear, but in the uniformity of texture, structure, and color of this brownish, friable, silty soil, with few or no rock fragments, is seen a close similarity to loess. On some of the more eroded areas limestone and sandstone fragments are of common occurrence and often the lower subsoil is more or less sandy. The subsoil portion of the type is no doubt mainly derived from limestone and sandstone. This is a good agricultural soil, giving under careful management fair to good returns with wheat, corn, clover, cowpeas, apples, and a number of other crops.

Volusia silt loam.—The soil of the Volusia silt loam, to an average depth of 8 inches, is a gray to brown silt loam. The subsoil, to a depth of 2 feet, is a light-yellow silt loam, at which point mottlings of gray or drab are encountered. Both soil and subsoil contain a high percentage of flat fragments of shale and sandstone ranging from 1 or 2 inches to a foot or more wide. In addition a considerable quantity of finely divided shale fragments is found in both soil and subsoil. The subsoil usually rests at varying depths below 18 inches on beds of shale or sandstone rock. The type is derived from the weathered products of the shale and sandstone, reworked by glaciation and slightly modified by extraneous glacial material. It occupies rolling and hilly land and is frequently interrupted or bordered by steep slopes not suited to agricultural purposes. The Volusia silt loam where properly cultivated is a good soil for timothy and small grains. In the eastern part of the region where it occurs it lies at too high an elevation to be well adapted to corn. In this locality buckwheat and potatoes are grown to advantage.

Wallpack silt loam.—The type consists of a light yellowish gray or yellowish brown silty loam or silt loam, 7 inches deep, underlain by a light yellowish brown or yellow silty loam or loam. Both soil and subsoil carry fragments of chert, limestone, and shale, ranging rather larger in size in the subsoil. The topography varies from gently rolling to sloping, the type occurring on a subordinate ridge of the Kittatinny Mountain in New Jersey. Drainage is good, and fair yields of wheat, rye, oats, corn, and hay are secured. The native forest growth is largely oak and chestnut.

Worth silt loam.—The surface soil consists of a light-brown to yellowish mellow silt loam from 6 to 10 inches deep. The subsoil is about the same or slightly more yellow in color and somewhat more compact in structure. Both soil and subsoil contain a large quantity of flat, angular shale, arenaceous and relatively thick bedded. Some rounded and subangular foreign glacial stones are also found. The topography is usually hilly, with moderate slopes, the elevations ranging from 1,000 to 1,700 feet above sea level. Drainage is good, the moisture-holding capacity of the type being excellent. Where not too stony the soil is easily cultivated. Corn for silage, oats, hay, buckwheat, and potatoes are the principal crops grown, fair yields being secured.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Marshall silt loam	Illinois 2, 5, 6, 8, 9, 11; Indiana 3, 10; Iowa 4; Kansas 2, 7; Louisiana 7; Missouri 1, 6, 10, 13, 16, 18; Nebraska 3, 5, 6; Wisconsin 5, 14.	3,480,902
Knox silt loam	Illinois 3, 5, 6, 7, 8, 10, 11; Indiana 2, 3, 8, 10; Iowa 2, 4; Kentucky 6; Missouri 4, 6, 8, 10, 13, 14, 16, 18; Nebraska 5; Wisconsin 3, 5, 7, 9, 14.	2,576,832
Memphis silt loam	Illinois 4, 7, 9; Kentucky 1; Louisiana 7, 10; Mississippi 1, 4, 6, 7, 13, 19, 21; Missouri 14; Tennessee 8.	2,035,642
Volusia silt loam	Indiana 9; New York 2, 3, 6, 9, 11, 13, 15; Ohio 10; Pennsylvania 4, 7.	1,364,928
Putnam silt loam	Missouri 2, 12, 13, 17, 19, 20, 21	1,050,112
Carrington silt loam	Indiana 10; Minnesota 1, 5; North Dakota 2, 5; South Dakota 2; Wisconsin 3, 4, 6.	856,640
Marion silt loam	Illinois 1, 2, 9; Missouri 14	695,040
Miami silt loam	Illnois 2; Indiana 10; Wisconsin 3, 4, 6, 15	455,104
Lexington silt loam	Tennessee 6, 8	342,272
Union silt loam	Missouri 8	254,528
Richland silt loam	Louisiana 6; Mississippi 1, 6	164,352
Dutchess silt loam	New York 4, 17	129,984
Lackawanna silt loam	Pennsylvania 4	115,200
Carroll silt loam	Louisiana 6	83,584
Mohawk silt loam	New York 11	45,440
Scottsburg silt loam	Indiana 9	37,184
Safford silt loam	Tennessee 6	28,544
Farmimgton silt loam	New York 5	25,856
Portage silt loam	Wisconsin 11	22,656
Ontario silt loam	New York 10	18,688
Worth silt loam	New York 5	16,128
Judson silt loam	Missouri 1, 4	10,688
Caribou silt loam	Maine 1	10,176
Wallpack silt loam	New Jersey 2	7,232
Hamburg silt loam	Missouri 1	3,008
Total		13,830,720

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

While the silty clay loams have been encountered in a number of instances in the Glacial Lake and River Terrace province, but two types of soil of this texture have been found in this province. These soils are somewhat heavier than the silt-loam group and require careful and timely cultivation under proper moisture conditions to prevent clodding. They can be worked into a fairly mellow seed bed, however, when properly cultivated. The phase is very retentive of moisture and is well adapted to such crops as wheat, barley, and the grasses.

Dutchess silty clay loam.—The soil is a brown to rather dark brown mellow silty clay loam 8 inches deep, overlying a brown, heavy, and compact silty clay

loam. Varying quantities of dark-colored thin shale chips and fragments of the country rock occur at the surface and throughout the section. The soil is in some places comparatively thin, so that the underlying rock approaches within 2 feet of the surface. The topography is rolling to hilly, though not usually too steep for cultivation, except in the immediate vicinity of stream valleys, which are in many places quite narrow and steeply cut. While the surface run-off is adequate there is some deficiency of underdrainage due to the close structure and heavy texture of the subsoil and nearness of the underlying rock. Corn, oats, hay, and buckwheat are the chief crops grown. Potatoes can be profitably grown over the deeper areas.

Lackawanna silty clay loam.—The type consists of a red to reddish-brown heavy silt loam or silty clay loam, about 6 inches deep, overlying a subsoil varying in texture from a silty clay loam to a clay loam, and of Indian-red color. In places the deep subsoil is slightly mottled with bluish gray. Both soil and subsoil contain a rather high content of fragments of red sandstones and argillaceous shales of the Catskill formation. The topography is gently rolling to hilly, the type usually occurring on comparatively gentle slopes between the steep-sided hills of the Lackawanna silt loam and the drainage channels below. Artificial drainage is often necessary on this type on account of its rather deficient slope and the impervious character of the subsoil. Well-drained areas in good physical condition produce slightly lower yields than the Lackawanna silt loam.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Dutchess silty clay loam	New York 5	13,120
Lackawanna silty clay loam	Pennsylvania 4	4,736
Total		17,856

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

This group, while comprising but four types, is important by reason of the wide distribution of the Miami clay loam. This type is one of the most intensively cultivated and most productive of any glacial till soil used for the general farm crops. The surface soil contains enough of silt and the finer grades of sand to render it friable and nearly as easily cultivated as a silt loam, yet the heavy, retentive subsoil lying within 10 inches of the surface forms an excellent reservoir for the storage of atmospheric waters. The soil is very drought resistant, and for this reason is nearly or equally as well adapted to corn as the Marshall silt loam, while it has no superior in the production of wheat and grass. Together with the various phases, the clay loams constitute the heaviest textured soils of the province and are well adapted to the heavier types of grains, such as wheat and barley, and to the production of timothy, clover, and alsike hay. The soils are too heavy for satisfactory results with such crops as potatoes, and are adapted to only a few of the heavier vegetables, such as cabbage. Artificial drainage is required on the greater proportion of the areas of this class of soils, since the surface slope is often insufficient to carry away surface waters and the subsoils are so impervious as to impede their passage downward. Thorough systems of tile drainage are always beneficial on these soils.

Carrington clay loam.—The type consists of a dark-brown to black clay loam, averaging about 12 inches in depth, underlain by a light-brown, yellowish-brown, or grayish, rather stiff and plastic silty clay. A small quantity of coarse material, such as gravel, stone, and bowlders, is found throughout the soil section, but not in sufficient quantity to interfere with cultivation. The topography varies from nearly level to undulating or slightly rolling, and artificial drainage is necessary in many areas, principally on account of the dense, impervious subsoil. The soil is derived from the weathering of glacial till under conditions favoring the accumulation of considerable organic matter. The type is a good corn, wheat, and grass soil. Some oats, barley, and flax is also grown, as well as sugar beets and cabbage in some of the areas.

Kewaunee clay loam.—The surface soil consists of a reddish brown silty clay about 8 inches deep. The subsoil to a depth of 3 feet or more is a red, heavy, plastic clay. The soil, on account of the low content of organic matter, is apt to become compact and assume a lighter color when dry. It is derived from the weathering of glacial till. Gravel and bowlders are found in varying amounts throughout the soil section. The topography is gently undulating to rather strongly rolling.

Miami clay loam.—The soil to an average depth of 10 inches consists of a yellowish-gray to light-brown, somewhat silty loam, underlain by light-brown to yellow or mottled stiff silty clay loam or clay, which is in turn underlain by bowlder clay at depths varying from 5 to 10 feet. Stones and erratic bowlders are found on the surface, but in no great quantity except in small areas. The type occupies uplands. The topography is nearly level to gently rolling, except near streams and near terminal moraines, where it becomes hilly and broken. The flat interstream areas generally require artificial drainage. The soil is fairly good for general farming, and is especially adapted to corn, wheat, hay, and ensilage crops, dairy farming, the heavy vegetables for winter use, and to apples for the winter market.

Mohawk clay loam.—The surface soil to a depth of 9 inches is a heavy silty clay loam, having a dark-brown or grayish-brown color. From 9 to 24 inches it is a lighter brown silty clay loam. Usually below 24 inches it grades into a stiff clay loam, not infrequently dark colored from the presence of some partly decomposed calcareous shale and limestone fragments. In topography it is rolling to hilly and ridged. The surface drainage is good, though the drainage of the subsoil is frequently poor. It is an excellent grass, corn, and clover soil and produces good yields of oats, making an admirable soil for dairy farming. The type is not well suited to potatoes and root crops.

Volusia clay loam.—The soil to a depth of about 8 inches is a dark-yellow or brown heavy loam or clay loam. The subsoil is a pale-yellow or drab clay loam. Both soil and subsoil contain a considerable quantity of shale and sandstone chips and sometimes larger pieces of stone. Some large erratic bowlders occur, but are not abundant. The deep subsoil is locally called "blue clay." The surface is rolling and irregular and sometimes morainal in character. The type is well adapted to general farming, but is in need of drainage. It is a strong soil for wheat, buckwheat, grass, and for corn where the elevation is not too great. It is also a good dairying type, and some vegetables and fruits are produced for canning and winter storage.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Miami clay loam	Indiana 1, 4, 5, 6; Iowa 3; Michigan 1, 2, 5, 6, 7, 8; Ohio 2, 3, 4, 7, 9, 10; Wisconsin 12, 15.	2,312,330
Carrington clay loam	Iowa 1, 3; Minnesota 1, 5; North Dakota 8; Wisconsin 12, 15	613,120
Kewaunee clayloam	Wisconsin 4, 8	121,216
Volusia clay loam	New York 15; Pennsylvania 7	105,088
Mohawk clay loam	New York 11	67,200
Total		3,218,954

[1] For key to numbers in this column see p. 733.

BLACK CLAY LOAM PHASE.

This phase differs from the clay loam of the Carrington and Marshall series in containing a higher percentage of organic matter and in occupying level to slightly depressed areas, where natural drainage is poorer and where ditching or tiling is ordinarily necessary before cultivated crops can be grown. The soil areas are comparatively small, ranging from one-fourth acre to 100 acres, or in rare instances as much as 1,000 acres. The greater part of such areas, however, contain only a few acres and are irregular in size and shape, so that it is the common practice to cultivate them along with an associated soil type in the same field. Their natural crop adaptation is generally quite different, and whenever the areas are large enough to handle separately different crops are grown. The phase is especially well suited to corn, but is not so well suited to wheat and other small grains, because the growth of straw is so rank that the grain almost invariably lodges and can not be economically harvested.

Carrington black clay loam.—The soil, which is a black clay loam of high organic matter content, is underlain at 10 or 12 inches by tenacious, dark-gray or drab silty clay. It occurs generally as level or depressed areas having insufficient drainage outlets. It represents residual material derived from glacial till and subjected to poor drainage conditions under which large quantities of organic matter have accumulated in the soil from the decay of water-loving plants. When well drained the type is highly productive, the best results being secured with corn and grass. Grain crops are inclined to lodge.

Marshall black clay loam.—This soil is a black clay loam 10 to 12 inches deep, underlain by a tenacious, drab clay. The type is of glacial origin, is generally level, and the natural drainage is poor. Where thoroughly drained it is very productive, particularly for corn. It is less well adapted to wheat on account of the liability of the grain to lodge, but is well suited to hay and dairying, and to some of the heavier garden crops, such as cabbage.

Area and distribution of the black clay loams.

Soil name.	State or area.[1]	Acres.
Marshall black clay loam	Illinois 5, 6, 8, 10; Indiana 10	228,224
Carrington black clay loam	Indiana 1, 4, 5, 6, 7; Iowa 1; Michigan 6, 7; North Dakota 5; Ohio 2, 4, 7, 9.	210,512
Total		438,736

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

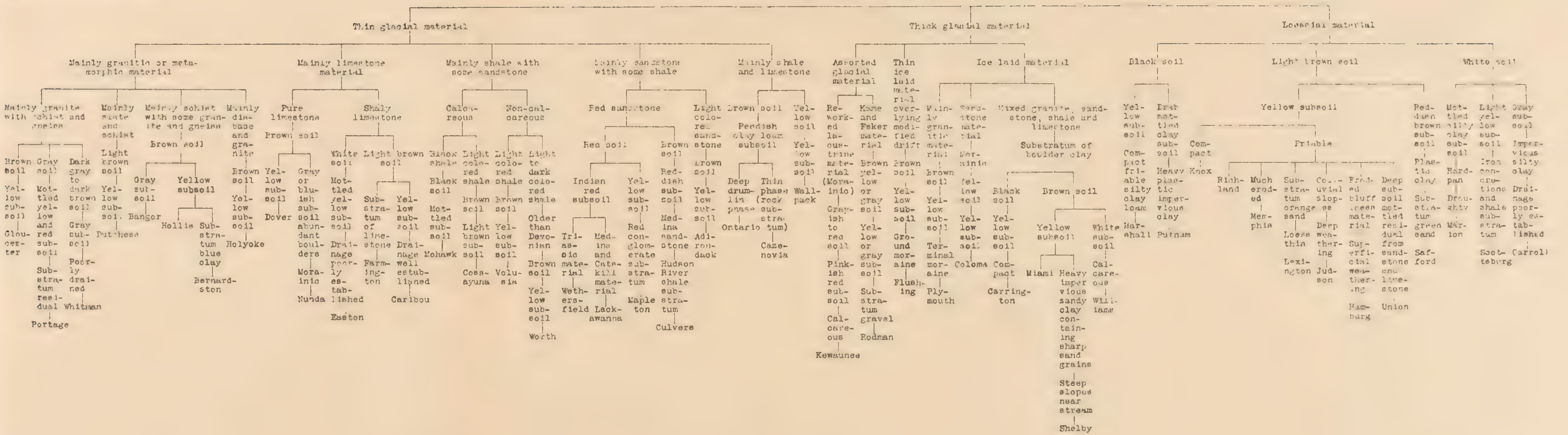
Area and distribution of the soil of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough stony land	Connecticut 2; Illinois 3, 4, 7; Indiana 3; Iowa 2; Kansas 2; Maine 2; Massachusetts 2; Michigan 4; Minnesota 2, 6; Missouri 14; New Hampshire 1; New Jersey 2; New York 4, 11, 12, 15, 17; Pennsylvania 4; Rhode Island 1; Wisconsin 3, 9.	1,190,208
Rock outcrop	Minnesota 2, 6; New Hampshire 1; New Jersey 2; New York 4, 5, 16, 17; Vermont 1; Wisconsin 13.	276,224
Muck	Indiana 1; Maine 2; Massachusetts 2; New York 11; Wisconsin 3, 5, 10.	248,256
Peat	Maine 2; Minnesota 5; Wisconsin 3, 8, 15	156,928
Steep broken land	Pennsylvania 4	25,344
Dunesand	North Dakota 9; Wisconsin 5	21,248
Rough broken land	North Dakota 2, 5	6,208
Made land	New York 4, 14	1,024
Waste land	New Jersey 2	448
Total		1,925,888

[1] For key to numbers in this column see p. 733.

Revision of September, 1912.

Key to the Soils of the Glacial and Loessial Province.



SOILS OF THE GLACIAL LAKE AND RIVER TERRACE PROVINCE.

By J. E. Lapham and Curtis F. Marbut.

DESCRIPTION OF THE PROVINCE.

The Glacial Lake and River Terrace province embraces two series of deposits. The first series includes deposits in the basins of lakes formed by the advance and retreat of ice during the Glacial Period. These were either temporary lakes, which took form during the period of retreat in a given locality only, and which ceased to exist when the ice had passed from that locality, or they may have been permanent lakes, caused by the reforming of the land surface during the Glacial Period, which persisted for a long time after the retreat of the ice, and which ceased to exist only through the operation of natural drainage forces, either by draining the basins or filling them with silt. These deposits are therefore widely distributed over the glacial region, especially the northern part.

The second series of deposits consists of those left within the glaciated area by the streams that flowed from the ice during the Glacial Period. These streams were presumably more abundantly supplied with water from the melting ice than at present from the normal rainfall of the glacial region. They also carried large quantities of gravel, sand, and finer material, which, owing to the great volume and transporting power of the streams, were carried into the valleys and deposited, forming new slopes, whose grades were determined by the load and current of the streams. Since the retreat of the ice and the reduction in the volume of the streams and the amount of their load they have cut newer valleys in these old valley fillings, leaving the uneroded remnants as terraces along the sides.

These features are more or less clearly developed along the larger streams within the glacial region both east and west. They are usually higher above the present valley floors in the eastern mountain areas, where they consist of coarser material than in the smoother regions of the west. In general the western terraces are made up of sands and silts whose original source is unknown, while in the mountain regions they are composed largely of cobbles and gravels, whose character and parent rock and, through the latter, the original source of the material, can often be determined.

BOUNDARIES.

The province does not occur as a single large area, but as a great number of small areas, many of them a square mile or less in size, the river terraces being developed as narrow strips along the larger rivers of the glacial region. It is therefore impossible to describe definitely the boundaries of the province as a whole or the location of a part of the areas. In general, however, the larger areas lie within the basins of the great lakes, and represent temporary glacial lakes or extensions of the existing Great Lakes formed during the Glacial Period.

TOPOGRAPHY.

The surface features of all these areas are essentially alike. The topography is generally flat, or nearly so, though not usually level, the areas consisting of smooth to gently undulating plains. As a rule, there is sufficient slope to provide good natural drainage or to render artificial drains effective. Since the province includes areas of glacial-lake deposits, not merely the areas covered at one time by glacial lakes, it is evident that the topography could not, as a whole, have been rough when the lake beds were exposed. It would have, even where not perfectly smooth, the smooth outlines of constructional forms. These areas are so recent that erosion by streams has had very little modifying effect on the topography.

GEOLOGY.

The lake deposits are usually thicker than the normal 3-foot soil section. The material has been derived from various sources, so that, taken as a whole, its ultimate source can not be determined.

In the eastern areas the material consists of grayish and bluish to yellowish clays, silts, and silty clays, with gray to brown sands and gravels. In the Lake Superior and other Wisconsin and eastern Minnesota areas the heavy material consists of red clays, and the light material is lighter in color. In the extreme western areas the materials are again bluish, yellowish, and gray.

In some cases, usually in small local areas, the lake silts and clays form a thin mantle, overlying either glacial drift or country rock. In such cases the silts have no closer genetic relationship to the underlying rock, as a rule, than do the thicker layers. The rock may be any of the formations that occur in the Great Lake region.

The most important areas of the Glacial Lake and River Terrace province are: (1) The Iroquois-Warren Basin, (2) the Maumee Basin, (3) the Saginaw Basin, (4) the Chicago Basin, (5) the Green Bay Basin, (6) the Duluth Basin, and (7) the Agassiz Basin.

THE IROQUOIS-WARREN BASIN.

This area lies in the Ontario plain in northern New York, with small extensions southward up the finger-lake valleys into the Allegheny Plateau, a narrow belt along the south shore of Lake Erie to eastern Ohio, where it again expands into the Maumee Basin, and a narrow belt down the St. Lawrence to the international boundary.

The northern or inner boundary of the area lies along the Ontario shore. The eastern end of the southern or outer boundary commences with a sweeping curve along and around the northwest and west foot of the Adirondacks, thence southward to Rome, N. Y., and westward in a curve by Syracuse to Auburn. West of this it follows a very irregular line in and out of the finger-lake basins westward to the vicinity of Le Roy, N. Y., beyond which it extends southwestward to the narrow belt along the Erie shore.

From Wayne County, N. Y., westward this basin is divided by an island belt on which the deposits do not occur. It runs westward through Monroe and into Genesee and Orleans Counties. The exact boundaries of its western end are not known.

This area contains practically no rough land. Some of the shore deposits occupy hillsides, and some areas have been eroded since deposition occurred, but these are small.

The soils are Dunkirk and Clyde, with a number of less important groups. The area is devoted as a whole to general farming, but in places the growing of fruit, especially apples, receives particular attention. The industry is best developed along the northern belt in Monroe, Orleans, and Niagara Counties, which represent the most important apple-growing region in New York, and one of the most important in the United States. Locally some attention is paid to peach growing, apparently with good results. Aside from fruit growing the land is devoted to the production of hay, pasture grass, wheat, beans, corn, potatoes, and vegetables.

In the narrow Erie shore belt the growing of grapes has developed into an industry of the greatest importance. They are grown mainly for table use and are shipped over a large part of the United States. In recent years large plants for the manufacture of grape juice have been established in the region, and this has increased the consumption of grapes and caused an extension of the industry.

Throughout the area the Clyde soils are utilized to a greater or less extent in the growing of cabbage, onions, celery, and lettuce.

THE MAUMEE AREA.

This area is developed as a fringe along the south side and west end of Lake Erie, extending southwestward from the end of the lake to Fort Wayne, Ind., and northward as a narrow fringe along the Detroit River, Lake St. Clair, and

the St. Clair River. It is mainly a feature of the southwestern end of the Lake Erie Basin.

It has a smoother surface than the Iroquois-Warren area, and consists of a practically uniform plain with a gentle slope toward the lake. Within this area are a few narrow, curving island areas belonging in the Glacial and Loessial province.

The soils belong to the Dunkirk and Clyde series. They are devoted mainly to general farming, which is conducted profitably, corn being the principal crop.

THE SAGINAW AREA.

This area occurs around the southern end of Saginaw Bay, Mich. It is connected by a narrow strip around "The Thumb" of Michigan with the Maumee area, and narrows down to a point on the west side of the bay near the junction with Lake Huron. The area is widest at its southern end, where it reaches a north and south width of about 40 miles and an east and west width of a few miles more. Topographically it is, like the Maumee area, a smooth plain with a gentle slope toward the Saginaw River and the bay. It includes very few, if any, islands in it.

The Clyde soils predominate and make up about 80 per cent of the area. They are devoted to general farming and dairying, but considerable attention is paid to the growing of sugar beets on the heavier members of the series. The greater part of the area is in a high state of cultivation and the farmers are prosperous.

THE CHICAGO AREA.

The area is small, and, owing to the fact that the city of Chicago lies within it, agriculture is not carried on in the northern or lake border belt to a sufficient extent to merit consideration. In the southern or Kankakee belt a large part of the land is under cultivation and devoted to the production of general farm crops, which in that region consist mainly of corn, oats, and hay. The topography of the area is smooth, except where sand dunes have been formed by wind action.

The soils are mainly Clyde and are usually light in texture.

A large part of this area is so poorly drained that it is not possible to grow crops on it. As a whole, the Chicago area is, therefore, of relatively little agricultural importance.

THE GREEN BAY AREA.

This area lies mainly along the west side of Lake Winnebago and the southern part of Green Bay, with a narrow and unimportant fringe along the shore of Lake Michigan, south of the mouth of the bay. On the eastern shore of the lake the belt varies in width from less than a mile to 4 or 5 miles, and between the Lake and the Bay the area has a considerable westward expansion.

The surface is smooth, resembling in this respect the Maumee and Chicago areas, being smoother than the southern part of the Iroquois-Warren area.

The soils are black to red in color, possess clay or silty clay subsoils, and belong principally in the Poygan and Superior series. Small areas and ridges of lighter colored sand and gravel occur.

This is a region of general and dairy farming, in which grass and the small grains constitute the main crops. Corn is grown to a less extent than in southern areas. Practically all of the area except local, poorly drained situations, is in a high state of cultivation.

THE SUPERIOR AREA.

This is a small area lying along the south shore of the west end of Lake Superior as a belt varying from a very few miles up to 15 or 20 miles in width. The topography is smooth and similar to that of the Green Bay area. The soil is essentially identical with that in the Green Bay area.

The principal crops are clover and timothy, both of which grow luxuriantly. Some attention is also given the production of root crops. The climate is generally too severe for corn, except as fodder.

THE AGASSIZ AREA.

This is the largest of the Glacial Lake areas. It lies in northwestern Minnesota and eastern North Dakota. It is broadest at the international boundary, where it has an east and west width of more than 200 miles. It narrows southward, ending in a point near the north end of Big Stone Lake in Minnesota. It reaches far across the line into Canada, having a north and south extent of about 250 miles. Its area within the United States is about 35,000 square miles.

Topographically, the area is smooth. It is one of the largest areas of almost perfectly smooth plain in North America. The Red River flows northward along the axis of the area, marking its lowest level, and the country rises imperceptibly east and west from this River. The area preserves its simple constructional surface features practically intact, the Red River having done nothing more than to cut a channel about 20 feet deep and only a few hundred yards wide. The other streams have affected the topography even less.

The predominant soils are those of the Fargo series. The Sioux soils are associated with them, but only in relatively small areas and narrow belts

This region has for a long time been the great spring-wheat producing area of the United States. Up to the last few years it was the most important area of its size in the world, but the plains of western Canada are fast becoming equally important in agriculture. It continues, however, as the most important area in the United States. The soil is fertile and particularly adapted to spring wheat, and the topography is favorable to the bonanza type of farming.

The continued cropping to wheat for a period of 20 years or more has caused a decided decrease in the yield per acre. This has turned the attention of the farmers to a greater diversification of crops. During the last few years more attention has been paid to oats, barley, and grass, though wheat continues to be the main crop.

THE RIVER TERRACES.

These deposits occur along all of the larger streams within the glacial area and along belts where no stream exists at present, but where temporary streams ran during a part of the Glacial Period, when they cut valleys and deposited soils of more or less importance in the area.

As a rule these terrace materials are coarser in the eastern part of the glacial province than in the western. The coarser grained and lighter soils are usually lighter colored than the heavier members. In the eastern part of the United States the glacial terrace soils are mainly those of the Merrimac series of the New England States, where they are composed of crystalline material, the Chenango soils of the Appalachian Mountain region, where they are made up largely of sandstone material, the Fishkill soils in parts of the Great Valley region, where they consist mainly of limestone material, and the Hoosic soils, also in the Great Valley region, where they are largely composed of shale material. The Chenango soils extend into the middle western States, and the Merrimac soils will probably be found in northern Michigan and northern Wisconsin, though none have been mapped so far. In the States west of the Mississippi River the terrace soils are darker in color, and are mapped as Sioux soils.

In the eastern part of the United States the river terrace soils are often relatively important on account of their level topography and favorable position. In many parts of the country they constitute the greater part of the smooth land available for agriculture, and where not so coarse in texture as to be extremely droughty they are valuable soils.

In the central western States the terrace soils are usually more productive than the upland soils, yet they are not so important relatively as in the East, on account of the larger areas of more highly productive upland soils.

These soils are devoted to general farming as a rule.

CLIMATE.

The Glacial Lake and River Terrace province, though geographically included within the Glacial and Loessial province, possesses distinct differences in climatic conditions which exercise a benefical influence upon crops, lengthen-

ing the growing season and rendering the soils of the region more valuable for fruit and truck growing than the till soils of the Glacial and Loessial province. The soils occupy relatively basinlike positions, and except where they occur on the leeward sides of large bodies of water they are as a rule less subject to drifting than the glacial till soils. The precipitation is also greater and more evenly distributed throughout the seasons than on the higher, more exposed till uplands.

The effect of the presence of large bodies of water in ameliorating the influence of late spring and early fall frosts is well illustrated by comparing the length of the growing season of Portland, Me., with Orono, Me., which is 187 and 136 days, respectively, and of Provincetown, Mass., with Middleboro, Mass., 194 and 141 days, respectively, Portland and Provincetown being seacoast towns, while Orono and Middleboro are situated in the interior. In the region of the Great Lakes this influence is strikingly illustrated by a comparison of Sandusky, Ohio, where the growing season extends over 195 days, with Canton, Ohio, 50 miles farther south, which has a frostless season of but 162 days. Likewise, Grand Haven, Mich., situated in the fruit belt on Lake Michigan, has a growing season of 165 days, contrasted with 140 days at Alma, Mich., situated near the center of the southern peninsula. This period of immunity from frosts extends over both the spring and fall ends of the season, thus giving the truckers and fruit growers an advantage in competition with their rivals working with inland soils.

There have been surveyed in this province 10,847,498 acres, of which 9,905,162 acres are mapped on a detail scale of 1 inch to the mile and 1,176,896 acres on a reconnoissance scale of 4 to 6 miles to the inch, with an overlap of 234,560 acres. Of the total area 9,943,014 acres have been classified according to material in series and 9,217,190 acres have been classified into types. In addition there are 904,484 acres of miscellaneous materials, mainly not suited to agriculture in their present condition.

DESCRIPTION OF THE SOIL SERIES.

Adams series.—The Adams series includes grayish-brown to brown or gray soils, with gray, brown, or yellowish subsoils deposited as deltas or shore material or in filled valleys in connection with glacial lakes, principally in New York State. The material has been carried down in streams of glacial age, mainly from glaciated shale and crystalline rock areas, and is essentially noncalcareous in character. The series differs from the Hudson in the absence of the heavy underlying clays usually associated with that series, and from the Hoosic series in being deposited in glacial lakes instead of as river terraces. The deposits are usually deep and the soils leachy and droughty, supporting a native vegetation of acid tolerant plants and trees.

Area and distribution of the soils of the Adams series.

Soil name.	State or area.[1]	Acres.
Adams sand	New York 5	24,000
fine sand	....do	21,248
gravelly loam	....do	320
Total		45,568

[1] For key to numbers in this column see p. 733.

Bearden series.—The Bearden series is characterized by dark-colored surface soils overlying gray or yellowish subsoils, which are somewhat calcareous and frequently contain shale fragments. It represents old alluvial material, probably deposited for the most part following the recession of the last ice sheet, and occurs as terraces or high first bottoms above overflow along some of the smaller streams in the prairie region of the Dakotas. This series differs from the Sioux soils in the absence of the gravelly layer with 3 or 4 feet of the surface, though coarse sands are sometimes present below the subsoil, and from the Wabash soils in the water table being farther below the surface, with consequently better drainage.

Area and distribution of the soil of the Bearden series.

Soil name.	State or area.[1]	Acres.
Bearden loam	North Dakota 8	3,584

[1] For key to number in this column see p. 733.

Benoit series.—The series is marked by dark brown to black surface soils, underlain by gray or yellowish, somewhat calcareous, subsoils, which grade into beds of gravel and sand at about 36 inches. Cobbles and small bowlders are frequently present on the surface and scattered through the subsoil. These soils are found near the margins of old glacial lakes and are of lacustrine origin. They are associated with gravelly and sandy bare ridges, which have been subsequently modified more or less by wind action. The topographic features of the Benoit series consist of numerous small shallow depressions and gentle swells between these ridges, and the aspect of the series as a whole is gently undulating. The soils are poorly drained, and their chief value is for hay meadows and pasture land.

Area and distribution of the soil of the Benoit series.

Soil name.	State or area.[1]	Acres.
Benoit fine sandy loam	Minnesota 3	4,032

[1] For key to number in this column see p. 733.

Caneadea series.—The Caneadea series consists of light-colored soils derived from the weathering of sediments laid down in temporary glacial lakes held at high levels. This series is distinguished from the Dunkirk series in that the soil-forming materials are comparatively local in character, having been washed from the shale and sandstone rock of the high-hill country of the surrounding region, or, in other words, they are the Volusia series materials deposited in water, while the soil-forming materials of the Dunkirk series are derived largely from materials foreign to the locality which were brought in by the ice invasion. It appears that the Caneadea series of soils were laid down during the time when the drainage outlets of the region were to the north, and that the soils of the Dunkirk series were laid down when the drainage outlets were to the east or west, farther north. The soils of this series are more or less local in extent, reaching their highest development in the Genesee River Valley above the high bank at Mount Morris, in southern Ontario County, and elsewhere at the southern extension of the small finger lakes in the hill country of New York State.

Area and distribution of the soils of the Caneadea series.

Soil name.	State or area.[1]	Acres.
Caneadea fine sand	New York 6	1,024
gravelly sandy loam	do	3,840
loam	do	4,160
gravelly loam	New York 6, 13	11,328
silt loam	do	14,720
clay	New York 6	1,280
Total		36,352

[1] For key to numbers in this column see p. 733.

Chapman series.—The Chapman series is characterized by yellow or light-brown surface soils with gray subsoils, though there is considerable variation in coloring and character of both surface and subsoils, in places underlying gray till coming to the surface or white silt pockets being present. The gray till in the depressions is sometimes covered by shallow deposits of muck or by masses of rock from the underlying formation, which in most places is a shaly lime-

stone. This series was derived from glacial till and is developed in a low plain country in northern New England, where the till is comparatively thin. The topography is hummocky, the hummocks being 4 or 5 feet in diameter and 1 or 2 feet above the intervening depressions. The hummocks are thought to have been formed by the overturning of trees. Drainage being obstructed, the soils are naturally too wet for cultivated crops and are in most general use for hay meadows and pasture lands.

Area and distribution of the soil of the Chapman series.

Soil name.	State or area.[1]	Acres.
Chapman loam	Maine 1	27,648

[1] For key to number in this column see p. 733.

Chenango series.—The Chenango series consists of yellowish to light-brown surface soils and brown to yellow subsoils. The surface soils vary in texture, but a consistent characteristic is the almost uniform occurrence at the depth of 3 feet or more of stratified gravel and coarse sand.

The series includes terrace soils, occurring along streams in those sections of the glaciated region where the upland soils result from the glacial grinding of limestones, shales, and fine-grained sandstones, with only a moderate admixture of material brought from areas of igneous and metamorphic rocks. The material forming the series was deposited along the glacial streams by relatively rapidly flowing waters associated with the melting and recession of ice masses. Upon the disappearance of the ice and the subsequent deeper erosion by the less voluminous postglacial streams, this material was left as terraces and is not now subject to overflow. The series is often associated with the Dunkirk series of lake deposits and forms southward extensions of similar material along old glacial drainageways. It is also developed in Ohio, Indiana, and some of the other Central States, where it was originally mapped as Miami gravelly loam.

The soils of this series are of high agricultural value and are adapted principally to corn, alfalfa, and other grasses, potatoes, and truck crops, depending upon the texture of the surface and the porosity of the subsoils.

Area and distribution of the soils of the Chenango series.

Soil name.	State or area.[1]	Acres.
Chenango sand	New Jersey 2	384
fine sand	do	512
sandy loam	Indiana 5; New Jersey 2; Pennsylvania 7	1,728
gravelly sandy loam	New York 3; Pennsylvania 4	7,680
fine sandy loam	New Jersey 2	3,072
loam	New Jersey 2; Pennsylvania 7	4,736
stony gravelly loam	Pennsylvania 4	26,496
gravelly loam	Indiana 5; Michigan 7; New York 2, 3; Ohio 4, 5, 7, 9, 10; Pennsylvania 7.	106,304
shale loam	New York 2, 3	10,368
silt loam	New Jersey 2; New York 2, 3; Pennsylvania 4, 7	26,432
undifferentiated	Pennsylvania 13	31,040
Total		218,752

[1] For key to numbers in this column see p. 733.

Clyde series.—This series is characterized by dark-brown to black surface soils and gray, drab, or mottled gray and yellowish subsoils, derived through deposition or reworking of the soil material in glacial lakes or ponds, the dark color of the surface soils being due to the high percentage of organic matter caused by the decay of plants in the presence of water under swampy conditions. The soils of the Clyde series grade into Muck and Peat on the one hand and such glacial-lake soils as the Dunkirk series on the other, without very sharp boundary lines. They are distinguished from the Poygan soils by the gray instead of reddish subsoils, and from the Fargo in the general absence of calcium carbonate. The topography is level and the soils are naturally

poorly drained, but when reclaimed they are highly productive and valuable for corn, grass, sugar beets, cabbage, and onions.

Area and distribution of the soils of the Clyde series.

Soil name.	State or area.[1]	Acres.
Clyde sand	Michigan 1, 2, 3, 7, 8	67,400
gravelly sand	Michigan 1, 8	24,656
fine sand	Indiana 7; New York 5, 6, 9, 13; Wisconsin 3, 4	66,624
sandy loam	Indiana 3; Michigan 2, 5, 8; Pennsylvania 7; Wisconsin 15	126,400
stony sandy loam	Michigan 8	8,000
fine sandy loam	Indiana 1; Michigan 6, 8; New York 5, 9, 10, 12; North Dakota 1; Wisconsin 3, 12.	103,936
loam	Indiana 1, 7; Michigan 1, 2, 5, 8; New York 6, 10, 11, 12; North Dakota 2; Wisconsin 3, 15.	519,852
silt loam	Michigan 8; New York 13; Wisconsin 3, 4, 8	36,736
clay loam	Michigan 10; New York 11; Wisconsin 12	16,960
silty clay loam	Wisconsin 4, 15	68,928
clay	Indiana 1, 3; Michigan 8, 9; New York 5, 12; North Dakota 1; Ohio 8.	319,040
Total		1,358,532

[1] For key to numbers in this column see p. 733.

Dunkirk series.—The Dunkirk soils are derived from the weathering of glacial-lake deposits, and include the lighter colored soils formed from such material. The surface soils range from brown to gray in color and the subsoils from brown to yellow or gray, with or without mottling. The topography varies with the thickness and character of the deposits as well as with the character of underlying topography It ranges from smooth to rough, the former, however, being the more characteristic.

The important criteria in distinguishing these soils are: (1) The derivation from glacial-lake deposits determined by (*a*) the nature of the material (clay, silt, gravel); (*b*) the smoothness of the topographic outline: (*c*) the stratification of the material; and (2) the color of the soil and subsoil.

Area and distribution of the soils of the Dunkirk series.

Soil name.	State or area.[1]	Acres.
Dunkirk sand	Michigan 9; Minnesota 3; North Dakota 8; Ohio 8; Pennsylvania 7; Wisconsin 8.	82,816
gravel	New York 6, 18; Ohio 1; Pennsylvania 7	8,744
gravelly sand	Michigan 5, 8; New York 6, 10	32,992
coarse sand	New York 11	3,200
fine sand	Indiana 1, 7; Michigan 5, 8; New York 1, 6, 8, 9, 10, 12, 13, 14; Pennsylvania 7; Wisconsin 10.	225,152
sandy loam	Indiana 1; Michigan 9; New York 11, 12, 13; Ohio 8, 10; Wisconsin 12.	69,632
gravelly sandy loam	New York 6, 10, 12, 13, 15, 18; Ohio 1; Pennsylvania 7	83,356
fine sandy loam	Indiana 1; New York 6, 8, 9, 10, 11, 12, 13, 14, 15, 18; Ohio 1, 3; Pennsylvania 7; Wisconsin 12.	266,698
loam	New York 1, 6, 10, 11, 12, 13, 15; Ohio 3; Pennsylvania 7	245,184
stony loam	New York 8	38,208
gravelly loam	New York 1, 6, 9, 10, 11, 13, 14, 15; Ohio 3; Pennsylvania 7	172,800
shale loam	New York 15; Pennsylvania 7	5,824
silt loam	New York 6, 8, 9, 10, 12, 13, 14, 15; Pennsylvania 7	162,944
clay loam	Michigan 10; New York 1, 9, 12, 15; Ohio 8	128,768
silty clay loam	New York 10, 13	55,232
clay	New York 1, 6, 8, 9, 11, 12, 13, 14, 18; Ohio 1, 3; Pennsylvania 7.	212,290
stony clay	New York 1, 6, 15	40,064
Total		1,833,904

[1] For key to numbers in this column see p. 733.

Elmwood series.—These soils are developed in a former high-level bed of the Great Lakes and are formed through the deposition of sandy material over lacustrine clays. The surface soils are yellowish or grayish in color, though darker in depressed areas where vegetable matter has accumulated. The clay subsoils are stratified. The topography is flat to undulating and the agricul-

tural value of the soils depends upon their ability to overcome the naturally poor surface drainage and the slowness with which water passes through the impervious clay subsoils. Fruit and general farm crops are grown upon the Elmwood loam in Michigan.

Area and distribution of the soil of the Elmwood series.

Soil name.	State or area.[1]	Acres.
Elmwood loam	Michigan 1	3,810

[1] For key to number in this column see p. 733.

Fargo series.—The series occurs principally in old Glacial Lake Agassiz in the Red River Valley and in other old glacial-lake beds in the same region. The soils have been formed by the reworking of glacial material and its deposition in glacial lakes. They are very black in color and contain a very large percentage of organic matter, in some cases enough to make them slightly mucky. There is also present, especially in the subsoil, a large percentage of lime. In this respect they differ from the Clyde soils, which are noncalcareous. The topography of this series is uniformly level.

Area and distribution of the soils of the Fargo series.

Soil name.	State or area.[1]	Acres.
Fargo sand	North Dakota 3, 8	51,520
fine sand	North Dakota 8, 9	164,160
sandy loam	North Dakota 9	53,504
gravelly sandy loam	Minnesota 3	24,447
fine sandy loam	Minnesota 1, 3; North Dakota 3, 4, 8, 9	432,384
loam	Minnesota 3, 4; North Dakota 1, 3, 4, 8, 9	393,984
gravelly loam	North Dakota 3, 9	6,528
silt loam	Minnesota 3, 5; North Dakota 4, 8, 9, 10	154,368
clay loam	Minnesota 1, 3, 5; North Dakota 3, 9; South Dakota 2	601,024
clay	Minnesota 1; North Dakota 3, 8, 9, 11	159,296
undifferentiated	North Dakota 10	694,784
Total		2,736,000

[1] For key to numbers in this column see p. 733.

Fox series.—The Fox soils are gray to brown in color and occur typically on a level topography. When the topography is not level its variation is due to the occurrence of potholes or to the existence of valleys eroded since the formation of the plain or the deposition of the material. The material was laid down either as outwash plains or as terraces along streams within the glacial area or flowing out of it. It consists largely or wholly of glacially derived material, but must contain a large percentage—at least 25 per cent—of limestone. This can be determined only through an examination of the gravelly material usually found in the subsoil.

Area and distribution of the soils of the Fox series.

Soil name.	State or area.[1]	Acres.
Fox sand	Wisconsin 8	2,368
fine sand	Wisconsin 3	9,344
sandy loam	Wisconsin 8	2,048
gravelly sandy loam	New York 4; Wisconsin 8	12,928
fine sandy loam	Wisconsin 3	704
loam	New York 4	1,600
gravelly loam	New Jersey 2; New York 4	42,624
silt loam	Wisconsin 4, 8	15,040
Total		86,656

[1] For key to numbers in this column see p. 733.

Hartford series.—The soils are red, brown, or yellow in the surface section, underlain by yellowish subsoils of a sandy character but containing little or no gravel, which constitutes one of the prominent characteristics of the Merrimac series. The soils were laid down in glacial lakes and deltas, the rock material coming mainly from areas of diabase or Triassic sandstone. They now exist as high terraces, principally in the Connecticut Valley, and the underdrainage is thorough, but not so excessive as in the Merrimac soils. The topography is level to undulating, the latter characteristic being due to wind action, which in some areas is at present an active force. These soils are most valuable for the production of truck crops and tobacco.

Area and distribution of the soils of the Hartford series.

Soil name.	State or area.[1]	Acres.
Hartford sandy loam	Connecticut 1; Massachusetts 1	95,304
very fine sandy loam	do	17,284
Total		112,588

[1] For key to numbers in this column see p. 733.

Hempstead series.—The Hempstead soils are brown to black in color in the soil, the darker color predominating in all except the lightest types. The subsoils are yellow to reddish yellow in color and are usually somewhat heavier than the soils. The subsoils rest on gravel or sand beds at about 24 inches from the surface. The gravel is mainly quartz. The topography is essentially level, the only relief consisting of dry-stream channels which traverse the area of these soils. They are derived from the weathering of glacial outwash material and have been identified only on the southern smooth prairie plains of Long Island. Where utilized at all they are used, under intensive fertilization and cultivation, for the production of market garden crops.

Area and distribution of the soils of the Hempstead series.

Soil name.	State or area.[1]	Acres.
Hempstead loam	New York 7	34,560
Hempstead gravelly loam	New York 7	19,264
Total		53,824

[1] For key to numbers in this column see p. 733.

Honeoye series.—The Honeoye series consists of brown loam soils of variable depth, but usually thin, and passing without much change in general color or physical character into the subsoil. The subsoil directly overlies the upper strata of Onondaga limestones of Devonian age, fragments of which occur throughout the soil profile. This material is residual from the weathering of the limestone, and mixed with it is usually found varying, though not large, quantities of glacial material left as remnants following the scouring by glacial stream. The series occupies valley positions where there has been considerable stream erosion in glacial times. The topography is usually gently undulating to rolling and sometimes slightly ridgy. The soils are so thin and stony that they are easily affected by drought and are comparatively little used for agriculture.

Area and distribution of the soil of the Honeoye series.

Soil name.	State or area.[1]	Acres.
Honeoye stony loam	New York 6, 10, 13	9,600

[1] For key to numbers in this column see p. 733.

Hoosic series.—This series consists of the high glacial terrace and delta soils found typically developed in eastern New York and western New England. They are brown to yellow in color and generally gravelly and sandy, especially in the lower depths. They are well elevated above present drainage channels and consequently well to excessively drained. The materials making up the series are derived from the mingled glacial and residual débris of the crystalline and semicrystalline rocks of the region. A large proportion of the gravel content consists of thin, waterworn shale and slate. These soils differ from the Merrimac series, which consist of broad flat terraces along the major streams of New England, and which are formed largely from wash from acidic rocks of a more coarsely crystalline character.

Area and distribution of the soils of the Hoosic series.

Soil name.	State or area.[1]	Acres.
Hoosic gravel	New York 17	31,232
coarse sand	do	6,080
fine sand	do	7,168
sandy loam	New Jersey 2	5,888
gravelly sandy loam	New York 17	8,640
loam	New Jersey 2	6,080
gravelly loam	do	26,240
silt loam	New York 17	4,288
Total		95,616

[1] For key to numbers in this column see p. 733.

Hudson series.—The soils are light brown to yellowish brown and are underlain by drab to yellowish subsoils. The latter are generally lighter in texture than the soils of the Vergennes series. They occur as glacial-lake terraces in the valley of the Hudson River south of the confluence with the Mohawk River. The material was deposited in Glacial Lake Albany and is composed principally of wash from glaciated slate uplands. These soils are lighter in color than the Vergennes soils and are noncalcareous.

Area and distribution of the soils of the Hudson series.

Soil name.	State or area.[1]	Acres.
Hudson sandy loam	New York 4	1,856
fine sandy loam	do	6,400
loam	do	3,904
silt loam	do	1,088
clay loam	do	9,984
Total		23,232

[1] For key to number in this column see p. 733.

Lidgerwood series.—The Lidgerwood series is marked by dark-brown soils with light-brown or mottled reddish, brown, and white subsoils, generally coarser in texture than the soils. The soils are developed in old abandoned preglacial stream channels in the Northwestern Prairie States, the material having been laid down by glacial waters. The topography varies from nearly level to somewhat hilly, the latter feature being possibly due to the action of wind. The drainage is variable, those areas which are low and wet furnishing good grazing land, while the higher-lying and hillier areas constitute good farming land for the production of the small grains, as well as potatoes and truck crops.

Area and distribution of the soil of the Lidgerwood series.

Soil name.	State or area.[1]	Acres.
Lidgerwood fine sandy loam	North Dakota 9	10,048

[1] For key to number in this column see p. 733.

Livingston series.—The series includes brown or grayish-brown surface soils about 10 inches in depth, underlain by gray and brown mottled subsoils of somewhat lighter color. The soils are derived from two sources. The subsoil in many instances is almost wholly residual in character from underlying shales, while the surface soil is formed through intermixture of this residual material with remnants of the glacial material surviving glacial stream action in the local valley positions where these soils are found. The topography is usually rather flat to gently rolling and the natural surface drainage poor. The soils are naturally well adapted to grass or pasture and when well drained produce good yields of general farm and grain crops.

Area and distribution of the soils of the Livingston series.

Soil name.	State or area.[1]	Acres.
Livingston loam	New York 6	13,504
silty clay loam	New York 13	6,208
Total		19,712

[1] For key to numbers in this column see p. 733.

Lockport series.—The Lockport series includes surface soils of light-brown, brown, or slightly reddish-brown color, overlying subsoils of distinctly Indian-red color and not infrequently mottled with yellow and light gray. These soils occur in the low Ontario Lake Plain in northern New York and are usually thin, the subsoils frequently grading into broken-up and more or less decomposed red Medina sandstone and shale, fragments of which frequently occur in the subsoil and sometimes at the surface. The soils have been formed both through the weathering of the underlying Medina formation and through the lacustrine sediments which have been left upon the recession of former Glacial Lake Iroquois. Drainage is usually poor and requires some artificial assistance. When drained these soils are used for the production of general farm crops, particularly the grains and grasses. Some fruits, such as apples, cherries, pears, quinces, etc., are produced upon the better-drained members of the series, and the value of the areas where the orchards have come into bearing ranges from $90 to $200 an acre.

Area and distribution of the soils of the Lockport series.

Soil name.	State or area.[1]	Acres.
Lockport fine sandy loam	New York 10	4,096
stony loam	do	12,544
clay	New York 12	6,656
Total		23,296

[1] For key to numbers in this column see p. 733.

Manchester series.—The soils of the Manchester series are generally rather sandy in texture and the surface soils are red or brown in color. The subsoils are red or reddish and in the lower part of the profile grade into the glacial till giving the Wethersfield series, which overlies the Triassic red sandstone formation. The series is formed from old alluvial or lacustrine sediments disposed as terraces in the Connecticut Valley, and their geographical occurrence is intermediate between the deeper lacustrine soils of the Hartford series and the till soils of the Wethersfield. The surface is generally rolling in character and the subsoils are porous enough to effect good underdrainage. As a rule, however, the subsoils are more retentive than those of the Hartford series and the series has a higher agricultural value. Fruit, early truck, grains, and tobacco are grown upon the Manchester soils.

Area and distribution of the soils of the Manchester series.

Soil name.	State or area.[1]	Acres.
Manchester fine sand	Connecticut 1; Massachusetts 1	46,462
sandy loam	do	44,160
Total		90,622

[1] For key to numbers in this column see p. 733.

Mankato series.—The soils are brown to black in color and grade into reddish-brown, sandy-textured subsoils, which directly overlie the bedrock of sandstone or arenaceous Shakoper limestone of Ordovician age. The soil material varies in depth, but is usually not more than 1 or 2 feet in thickness over the bedrock. In some places the rock outcrops and in others glacial bowlders are present. The surface soils are derived from alluvium deposited by streams probably of Glacial age, while the subsoils are to a considerable extent residual. The soils occur as high terraces along rivers in the Central Prairie and Northwestern States. The topography varies from level to rolling. The more sandy members of the series are porous and inclined to be droughty, while the heavier soils frequently require artificial drainage. The soils are adapted to truck crops, general farm crops, and pasture land, depending upon the texture and drainage.

Area and distribution of the soils of the Mankato series.

Soil name.	State or area.[1]	Acres.
Mankato sand	Missouri 20	448
sandy loam	Minnesota 1	2,816
loam	do	1,600
Total		4,864

[1] For key to numbers in this column see p. 733.

Merrimac series.—The surface soils of the Merrimac series are brown to light brown in color and are usually underlain by yellowish sand and gravel. This series is found almost entirely in the New England States and constitutes the glacial terraces which occur along nearly all the streams of this section. The material consists principally of crystalline rocks which were ground up by the ice, reworked by water, and deposited during the close of the Glacial period. These soils are abundantly developed in New England and eastern New York on high terraces along the streams. From their composition and structure they are usually leachy soils, especially the coarser-textured members.

Area and distribution of the soils of the Merrimac series.

Soil name.	State or area.[1]	Acres.
Merrimac sand	New Hampshire 1, 2	44,480
coarse sand	Connecticut 1; Massachusetts 1; New Hampshire 1, 2; New York 7; Rhode Island 1.	138,568
sandy loam	Massachusetts 2	62,400
gravelly sandy loam	Connecticut 1, 2; Massachusetts 1, 2; New Hampshire 1, 2	259,412
coarse sandy loam	Connecticut 1; Massachusetts 1, 2; New York 7; Rhode Island 1.	247,616
fine sandy loam	Connecticut 2; Massachusetts 2; New Hampshire 2	26,432
silt loam	Rhode Island 1	4,928
Total		783,836

[1] For key to numbers in this column see p. 733.

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Newton series.—This series is marked by yellowish or brownish surface soils overlying beds of muck or peat, or sands or sandy loam, containing a large proportion of organic matter. The surface soils vary in depth from a few inches to 2 feet or less, though in some instances the depth may exceed 2 feet. The soils are formed by the deposition of material from glacial lakes or streams over highly organic deposits which have accumulated during conditions of instability of the glacial lakes at the close of the last glacial epoch. The topography is level to somewhat undulating or hummocky, where subsequent modification by wind action has taken place, and for the most part drainage is rather poor. On account of the generally low-lying position and unobstructed drainage, the soils are principally used for pasturage.

Area and distribution of the soil of the Newton series.

Soil name.	State or area.[1]	Acres.
Newton fine sand	Indiana 7	5,888

[1] For key to number in this column see p. 733.

Orono series.—The surface soils of the Orono series are light-brown and gray and the subsoils are gray. The heavier members occupy estuarine and glacial-lake plains or outwash plains and their drainage is good to excessive, while the lighter members are derived from esker and glacial-delta material, and artificial drainage is sometimes necessary. These soils are derived from stratified drift or glacio-moraine deposits. The crop adaptation varies with texture and drainage, the heavier soils being best suited to grass and grains, those of intermediate texture to general farming, and the light, sandy ones to special truck crops. The silty clay is one of the types largely in use for potatoes, principally because of its smooth topography and the ability to use machinery on it.

Area and distribution of the soils of the Orono series.

Soil name.	State or area.[1]	Acres.
Orono fine sand	Maine 2	3,264
gravelly sandy loam	do	4,352
fine sandy loam	do	640
silt loam	do	14,464
silty clay	do	83,200
Total		105,920

[1] For key to numbers in this column see p. 733.

Plainfield series.—The surface soils of the Plainfield series range in color from brown to grayish yellow, while the subsoils are usually yellow to pale yellow. This series is developed in the deep drift-covered areas of Wisconsin, Michigan, and Minnesota, and comprises soils formed from sandy and gravelly glacial débris washed out from the fronts of the glaciers. It is also developed as deep, filled-in valleys along major and minor streams like the Manistee and Au Sable Rivers in Michigan, and the Wisconsin River in Wisconsin. The first phase occurs as nearly level or gently sloping outwash aprons connected with terminal moraines, while the second is formed by the filling in of valleys, often several miles in width, during periods of former glaciation. Upon the flat floors of some of these valleys moraines of the later ice sheets have been deposited, leaving intermorainic exposures in the form of level plains. The greater part of the material of the series has been considerably assorted by voluminous glacial waters, and consists mainly of sand and gravel. The deposits are deep and the soils leachy and droughty.

Area and distribution of the soils of the Plainfield series.

Soil name.	State or area.[1]	Acres.
Plainfield sand	Michigan 5; Wisconsin 3, 5, 6, 7, 10, 11, 15, 16	327,552
fine sand	Wisconsin 3, 7	22,912
sandy loam	Illinois 11; Wisconsin 3, 5, 9	46,656
loam	Wisconsin 15	4,160
silt loam	Illinois 10; Wisconsin 3, 6, 15	58,048
fine sandy loam	Wisconsin 3, 15	10,752
Total		470,080

[1] For key to numbers in this column see p. 733.

Poygan series.—The surface soils of the Poygan series are dark brown to black in color, and differ from the Clyde soils in overlying the pinkish-red clay which gives rise to the Superior series. This series is associated with the Superior soils, and is developed chiefly in the Upper Peninsula of Michigan, Wisconsin, and Minnesota. The soils are level to gently undulating in topography and occur in old lake bottoms.

Area and distribution of the soils of the Poygan series.

Soil name.	State or area.[1]	Acres.
Poygan sand	Wisconsin 8	64
fine sandy loam	Wisconsin 4	320
silt loam	Wisconsin 8	384
clay loam	Wisconsin 16	23,232
clay	Wisconsin 4, 16	37,696
Total		61,696

[1] For key to numbers in this column see p. 733.

Saugatuck series.—The Saugatuck series is distinguished by the spotted appearance of the surface soils and the uniform presence of red subsoils. The soils are generally sandy in nature and the surface colors vary from white through gray and red to almost black, alternating with spots where underlying iron crusts, or hardpan, come to the surface or impart a decided red color to the soil. These spots vary in extent from 1 to several rods. The sandy material and iron crusts are underlain at from 3 to 6 feet by impervious lacustrine clays, and this, combined with the generally level or only slightly undulating topography, produces the obstructed drainage conditions under which the iron crusts are formed. The presence of the crusts is sufficient in some places to affect injuriously the penetration of the roots of crops or to interfere with the downward passage of surface waters. The series is typically developed in the fruit belt of western Michigan, and where the hardpan is not too near the surface and drainage is adequate fruit and general farm crops, including potatoes, do well.

Area and distribution of the soil of the Saugatuck series.

Soil name.	State or area.[1]	Acres.
Saugatuck sand	Michigan 1	24,120

[1] For key to number in this column see p. 733.

Sioux series.—This series occurs in the glaciated region of the Central and Northwestern States, and comprises the dark-brown to black terrace soils, characterized and distinguished from the Wabash series in occupying terraces above overflow and by a bed of gravel, usually within 3 feet of the surface. It differs from the Waukesha series in its occurrence as comparatively narrow areas along streams, instead of broad outwash plains associated with moraines.

The underlying gravel bed has a very marked effect upon the drainage of the soils. and causes crops to suffer in time of drought, except in areas where the gravel is several feet below the surface.

Area and distribution of the soils of the Sioux series.

Soil name.	State or area.[1]	Acres.
Sioux sand	Minnesota 1; Wisconsin 9, 14	37,696
sandy loam	Indiana 3, 10; Iowa 1; Minnesota 4, 5; Missouri 14; South Dakota 2; Wisconsin 6, 14.	141,056
gravelly sandy loam	Wisconsin 9	256
fine sandy loam	Minnesota 5; North Dakota 5; Wisconsin 9	11,520
loam	Illinois 10; Indiana 5, 10; North Dakota 8	73,920
gravelly loam	Minnesota 5; North Dakota 8	32,704
silt loam	Indiana 10; Minnesota 5; Wisconsin 9	9,082
clay loam	Indiana 4	2,240
clay	North Dakota 5	2,432
Total		310,906

[1] For key to numbers in this column see p. 733.

Suffield series.—The Suffield series includes dark-drab soils resting upon gray or drab subsoils. The subsoils are impervious and usually show stratification. The origin is from glacial lake or possibly marine sediments deposited during the Champlain period. The topography is level to gently undulating, often with sharply defined V-shaped erosion valleys, the soils occurring as terraces above the Connecticut River. Both surface and underdrainage are usually deficient, so that the soils are not used to any considerable extent for cultivated crops, being best adapted to grass.

Area and distribution of the soils of the Suffield series.

Soil name.	State or area.[1]	Acres.
Suffield loam	Connecticut 1; Massachusetts 1	18,878
clay	do	23,610
Total		42,488

[1] For key to numbers in this column see 733.

Superior series.—The surface soils are gray, brown, or reddish, with pinkish-red to light chocolate red, rather dense clay subsoils. The series comprises a group of glacial-lake soils developed principally along the margain of Lake Superior, but found to a lesser extent along the western shore of Lake Michigan and in central Wisconsin and Minnesota, and is largely confined to the heavier textured members, though in some places sands and sandy loams have been subsequently deposited on the red clay, giving rise to soils of a light sandy character. The topography is usually level to only slightly undulating, though erosion produces sharp V-shaped gullies and stream valleys. Stratification is usually present in the deep subsoils, which are calcareous. The series is well adapted to the production of grasses, grains, and the general farm crops.

Area and distribution of the soils of the Superior series.

Soil name.	State or area.[1]	Acres.
Superior sand	Wisconsin 7	14,848
sandy loam	Wisconsin 1, 13, 16	103,488
fine sandy loam	Wisconsin 7, 10	2,752
loam	Wisconsin 16	3,328
silt loam	Minnesota 2; Wisconsin 1	17,664
clay loam	Wisconsin 7, 8, 16	12,032
silty clay loam	Wisconsin 4	8,064
clay	Michigan 4; Minnesota 2, 6; Wisconsin 1, 2, 13	311,360
Total		473,536

[1] For key to numbers in this column see p. 733

Tonawanda series.—The surface soils are brown to black, and are underlain by subsoils consisting of two rather distinct members, the upper of drab or yellow and brown mottled heavy clay loam or sandy loam, grading sometimes into sticky sand of the color and consistency of brown sugar. The origin is stated to be from alluvium deposited upon glacial lake materials. The surface is low and flat or slightly undulating along streams. The soils as a whole are poorly drained and some areas are subject to overflow or inundation through lack of drainage. Fair crop yields are secured in good seasons, but favorable conditions are uncertain. The soils are in use to some extent for the production of the heavier types of truck crops.

Area and distribution of the soil of the Tonawanda series.

Soil name.	State or area.[1]	Acres.
Tonawanda loam	New York 12	15,168

[1] For key to number in this column see p. 733.

Tunkhannock series.—The Tunkhannock series consists of Indian-red soils and subsoils, developed as terraces in the Glacial Lake and River Terrace province, the types occurring above ordinary overflow, usually along relatively small streams in the glaciated region. The soil material is derived from the wash from red till upland soils like the Lackawanna. It also includes small areas of kame material which has been left in valleys or small V-shaped drainageways in the hills. It differs from the Lackawanna soils in being water assorted and from the Barbour soils in occupying a higher topographic position. The soils are like the Chenango soils, except in the matter of color, and are of about the same agricultural value.

Area and distribution of the soil of the Tunkhannock series.

Soil name.	State or area.[1]	Acres.
Tunkhannock gravelly loam	Pennsylvania 4	2,688

[1] For key to number in this column see p. 733.

Tuscarora series.—The surface soils of the Tuscarora series are light brown to gray in color, and the subsoils yellow or gray, sometimes mottled. The principal characteristic of this series is the sharp difference in texture between the usually rather sandy surface soils and the deep, dense, impervious clay subsoils. Alternating pockets of heavy and sandy material are occasionally found throughout the whole section. The heavy clay substratum usually occurs at about 30 inches, and is drab to mottled in color. These soils are thought to have been formed by the deposition of material from glacial lakes, the heavier substratum during the occupancy of the region by deep waters and the more sandy surface materials while the lakes were more shallow. The topography is nearly level and the drainage poor. The soils are principally valuable for hay where cleared of their natural vegetation of swamp grass, oak, and hickory.

Area and distribution of the soil of the Tuscarora series.

Soil name.	State or area.[1]	Acres.
Tuscarora sandy loam	New York 6	320

[1] For key to number in this column see p. 733.

Vergennes series.—The Vergennes series is marked by brown, yellowish, or gray soils underlain at varying depths by drab to blue or light-gray clay subsoils, often calcareous. This series occurs on the terraces surrounding Lake Champlain and in the St. Lawrence Valley, in northern New York. It consists

of deep-water sediments, known as the Champlain clays, deposited in postglacial times over glacial drift during a period of submergence. Since the uplift these clays have been more or less modified by stream action and colluvial wash from soils of the surrounding highlands derived from the underlying geological formations, usually sandstone, shale, and limestone, and in limited areas by wash from glacial drift soils. The surface is level to gently rolling, and for the most part artificial drainage is necessary.

Area and distribution of the soils of the Vergennes series.

Soil name.	State or area.[1]	Acres.
Vergennes sand	New York 5	1,024
gravelly sand	do	4,672
fine sand	New York 5, 16; Vermont 1	33,344
sandy loam	New York 16; Vermont 1	2,112
fine sandy loam	New York 5	3,392
loam	New York 5, 16; Vermont 1	23,936
stony loam	New York 5, 16, 17; Vermont 1	26,304
gravelly loam	New York 5, 16; Vermont 1	11,136
silt loam	New York 5	84,288
clay	New York 5, 16, 17; Vermont 1	430,912
black clay	New York 17; Vermont 1	4,224
Total		625,344

[1] For key to numbers in this column see p. 733.

Walcott series.—The soils of the Walcott series vary from dark-brown to gray in color, and range from loams or finer textured soils to sands, only the sandy loam so far having been recognized. This series has been recognized in the northern prairie States in connection with some of the old glacial lakes, such as Agassiz Lake, and the materials which go to make up the soils are of varying origin and characteristics. The series typically occupies the sites of old glacial lake shores. The heavier, darker colored phases possess many of the characteristics of the Fargo soils, while the lighter colored and more sandy material, which has been formed by wave action at the margins of the lakes, and been more or less assorted and piled up into hillocks and dunes by the winds possesses more the characteristics of Dunesand. The topography varies from level to gently rolling, undulating or hillocky. The crop yields vary with the character of the soil, the heavier phases producing fair yields of prairie hay, while the sand hillocks are of little value, except for some special truck crops.

Area and distribution of the soil of the Walcott series.

Soil name.	State or area.[1]	Acres.
Walcott sandy loam	North Dakota 9	3,264

[1] For key to number in this column see p. 733.

Warners series.—The characteristics of the Warners series are the brown to black, mucky surface soil, varying from less than an inch to several feet in depth, and the underlying subsoil material of soft white marl, which sometimes contains shells of snails and other land animals, though probably a considerable part of it is due to the deposition of calcium salts by plants, such as *Chara*, which are known to secrete this material. The type occupies level positions where the drainage has been obstructed, and more or less organic matter has accumulated and decayed. Little of this material has been reclaimed through drainage. It is principally uncleared and is used for pasturage.

Area and distribution of the soil of the Warners series.

Soil name.	State or area.[1]	Acres.
Warners loam	New York 6, 10, 14	2,560

[1] For key to numbers in this column see p. 733.

Washburn series.—The Washburn soils are dark-brown to nearly black and are high in the content of organic matter. They usually overlie grayish-yellow or mottled yellow and brown subsoils. The surface is strewn with glacial stones and bowlders of granite, gneiss, or sandstone, and some small shale fragments are also present, giving the soils a gravelly character. The deep substratum is composed of calcareous shale rock. The series is closely associated with muck, and the soil areas usually occur as narrow bands along small streams and areas of poor drainage. The soils are derived from an intermingling of glacial till and mucky material brought about through weathering, with loss of some of the original organic matter and the addition of more mineral matter. They are intermediate in character between the upland glacial till soils and the muck areas in northeastern New England. Their use for cultivated crops is dependent upon the establishment of drainage, as they are naturally too wet for anything but meadows.

Area and distribution of the soil of the Washburn series.

Soil name.	State or area.[1]	Acres.
Washburn loam	Maine 1	5,504

[1] For key to number in this column see p. 733.

Waukesha series.—The Waukesha series is characterized by dark-brown to black surface soils, underlain by yellow subsoils in which fine gravel is usually present. The color differentiation has been developed under prairie conditions. These soils occur in association with the Plainfield soils in the areas of deep drift in the Central Lake States. The Waukesha, like the Plainfield soils, are derived from water-assorted glacial débris deposited in broad filled-in valleys or as outwash plains and terraces and are sandy and gravelly in general character. They are more productive than the Plainfield soils, on account of their higher content of vegetable matter and greater moisture-holding capacity.

Area and distribution of the soils of the Waukesha series.

Soil name.	State or area.[1]	Acres.
Waukesha sand	Indiana 6, 7; Iowa 1; Wisconsin 16	36,992
sandy loam	Indiana 6, Wisconsin 11, 16	118,848
loam	Wisconsin 15	13,440
gravelly loam	do	704
Total		169,984

[1] For key to numbers in this column see p. 733.

Williston series.—The soils of the Williston series are brown to dark-brown in color and are underlain by light-brown or whitish subsoils. The subsoils are calcareous, and the presence of beds of sand and gravel is not an uncommon feature, particularly of the coarser members of the series. The series occurs as terraces about midway in elevation between the present flood plain and the uplands along some of the smaller tributaries of the Missouri River in North Dakota, the material having been deposited as glacial stream sediment. The topography is nearly level to somewhat rolling. Where considerable sand and gravel are present in the subsoils, drainage is apt to be excessive, so that unless irrigation is practiced the soils are droughty. The more loamy members, however, produce fair yields of grain and general farm crops in years of normal moisture.

Area and distribution of the soils of the Williston series.

Soil name.	State or area.[1]	Acres.
Williston sandy loam	North Dakota 11	3,584
gravelly sandy loam	do	12,352
gravelly loam	North Dakota 10	25,536
Total		41,472

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The sand group of this province differs from that of the Glacial and Loessial province principally in the character of its topography. The soils are generally level to slightly undulating, and in the case of the Chenango, Merrimac, and Sioux types, which occupy rather high terraces considerably above the level of ground water, they are underlain by beds of porous gravel and sand, so that they are peculiarly subject to drought. They are, therefore, not well adapted to general farm crops, and the yields of such crops are low, except in unusually wet seasons. Such soils are best adapted to some of the special early truck crops. The Plainfield and Waukesha occur as broader outwash plains and are better adapted to extensively cultivated field crops. The Clyde and Dunkirk sands occupy low topographic positions and are less excessively drained; in fact, artificial drainage is sometimes necessary where the types occur in slight depressions. The lighter types of general farm crops are sometimes grown on these soils and fair yields of corn, wheat, oats, rye, and sugar beets are secured. In some of the Michigan areas peppermint and chicory are among the unusual special crops grown on the Clyde sand. The Mankato and Saugatuck sands are types of local occurrence and are adapted to truck and small fruit.

The group as a whole is better adapted to the production of early vegetables and to peaches, plums, cherries, strawberries, and other small fruits than to the grain and grass crops.

Adams sand.—The soil of this type is a medium-textured brown sand about 6 inches deep, overlying a subsoil of yellow to grayish coarse sand. The material ranges in texture from medium to fine and is without much of the coarser grades of sand in some of the areas, while in others considerable fine gravel is present. The type usually occurs as terraces and deltas, and the topography is usually flat to gently rolling where it has been modified by the wind. Owing to the loose, porous character of the subsoil the type is excessively drained, being leachy and droughty. A large portion of the area in Jefferson County, N. Y., is known as the "pine plains," and is not used for agriculture. It is better adapted to forestry, though early potatoes and other vegetables and fruits such as strawberries could be produced under careful management. The native vegetation is white pine, birch, poplar, huckleberry bushes, sweet fern, etc.

Chenango sand.—The soil consists of a light-brown or yellowish-brown sand of medium texture and about 8 inches deep. The subsoil is a yellowish-brown to yellow sand, in places containing a small quantity of fine, rounded gravel. The topography varies from nearly level to undulating or rolling where the material is blown by the wind. The drainage is excessive and the type is leachy and droughty, so that its best adaptation is for certain special truck crops.

Clyde sand.—The soil consists of 12 inches of black medium to fine loamy sand, underlain by sand to a depth of 30 inches, which in turn is generally underlain by clay. The type occupies low, flat areas and is generally swampy and poorly drained. It is composed of reworked glacial sands, with the addition of organic matter. When well drained the soil produces fair crops of corn, wheat, grass, oats, rye, and all kinds of truck crops. It is a fair soil for sugar beets.

Dunkirk sand.—The soil consists of yellowish loamy fine to medium sand and is derived from terrace or shore-line deposits representing glacial material reworked by the waters of glacial lakes. The type occurs as nearly flat to undulating areas, parts of which require artificial drainage in order to be

put in condition for agricultural use. Only moderate yields of grass, corn, wheat, and truck crops are secured. Potatoes, apples, plums, and strawberries seem to give particularly good results.

Fargo sand.—This type has a dark surface soil, with an average depth of about 14 inches and varies in texture from a loamy sand to a heavy sandy loam, the sand particles being for the most part coarse. The subsoil is a yellow loamy sand or a coarse sandy loam, and occasionally clay is found at a depth of about 3 feet. There is no gravel in the soil, but a little fine gravel is sometimes found in the subsoil. The type is a delta deposit and has a very gently rolling to level topography. When thoroughly drained it is well adapted to truck and canning crops and the wet portions are best suited for hay production. If a good market were near dairying would be profitable upon this type. Fair yields of corn are obtained. The yields of wheat and other small grains are rather light. The greater part of the type is wet, wild land, from which some wild grass is cut for hay.

Fox sand.—The surface soil to a depth of 6 inches consists of a light-brown medium sand, loose and open in structure, and containing only a very small quantity of organic matter. The subsoil is a yellowish-brown, loose fine sand. Red clay is usually encountered in the deeper subsoil. Beds of gravel are found at a depth of 3 feet. The topography is flat to gently undulating, though the type is sometimes found on stream terraces. The natural drainage is excessive. With the addition of stable manure and commercial fertilizers, the type is adapted to early truck crops.

Mankato sand.—The soil is a brown or yellow loamy sand, 10 inches deep, grading into reddish-yellow sand of medium texture, underlain at from 24 to 36 inches by sandstone in place. The subsoil is derived from underlying rock, the surface soil being a covering of wash material. This type occurs as gently rolling upland just above the second bottoms. It is adapted to truck, small fruit, peaches, and wrapper leaf tobacco.

Merrimac sand.—The surface soil consists of a gray to light or dark brown, medium-textured sand, extending to a depth of 3 feet. The subsoil is a yellowish sand of about the same texture and composition as the surface material. There is usually a noticeable proportion of fine sand in some areas occupying higher elevations, where more or less wind-blown material has accumulated, while in other areas the soil tends to the other extreme, approximating a coarse sand in texture and carrying some gravel. The type occurs along streams, ponds, and lakes, and is derived from reworked glacial drift modified by wind action. The characteristic native vegetation is white pine and coarse grasses. Little of the type is under cultivation, but the better areas are devoted to corn and grass. It is best adapted to the production of early truck crops.

Plainfield sand.—The surface soil consists of a brown to yellow, slightly loamy sand, about 10 inches deep. The subsoil is a heavy, loose, yellowish-brown medium sand, which becomes lighter in color and coarser in texture as depth increases. A small proportion of fine gravel is commonly encountered at a depth of about 2 feet. Practically no stones are to be found on the surface of this soil. The type occupies broad, level, filled-in valleys and outwash plains of glacial material which has been left by the action of swift glacial waters. Owing to the loose, porous nature of both the soil and subsoil, the type is excessively well drained and light yields are secured, especially in dry seasons. In wet seasons the yields are fair. Potatoes give the best results. Corn, rye, oats, and hay are the other crops commonly grown.

Poygan sand.—The surface soil is a black sand to light sandy loam, about 10 inches deep. The subsoil is a light-brown or grayish sand to a depth of 3 feet, where red silty clay or clay is encountered. The topography is level to slightly undulating, though where the sand subsoil is 30 inches or more in depth the drainage is usually good. In level areas where the red clay reaches to within 2 feet of the surface drainage is deficient, and tiling or ditching should be resorted to. The clay substratum usually forms a sufficient moisture reservoir to prevent crops from suffering materially from drought in dry seasons. The native timber growth consisted of hardwoods, principally maple and ash, with some hemlock. While the red clay of the subsoil is usually neutral or slightly calcareous, the overlying sand is apt to be acid in reaction and lime applications are needed. Corn, oats, and potatoes are the principal crops grown, the yields being of only fair size.

Saugatuck sand.—The surface soil consists of reddish-brown, black, and gray sand, 9 inches deep. The subsoil to a depth of 3 feet or more consists of medium fine sand, containing bands of sand cemented by ferruginous material.

These bands of iron crusts vary from a fraction of an inch to a foot or more in thickness. The type occupies slightly depressed areas. It is best adapted to truck, peaches, and small fruits. Grain does fairly well.

Sioux sand.—The surface soil is a dark-brown or black medium sand, which in some places is slightly loamy. At a depth of from 12 to 18 inches it is underlain by a yellowish sand, which sometimes contains a small quantity of fine gravel. The gravel content increases with the depth of the material and constitutes a rather high percentage at a depth of 3 feet or slightly more. The areas of the type occur in the form of terraces along streams and are above overflow. While the topography is usually flat or only gently undulating, the presence of the porous gravel in the subsoil provides good to excessive underdrainage, so that the type is often droughty. The soil warms up early in the spring, however, and produces fair crops, especially in moist seasons. It is used for corn, wheat, rye, and potatoes, being better adapted to the latter and to truck crops than to general farming or dairying.

Superior sand.—The surface soil is a grayish-brown sand of medium to rather fine texture, extending to a depth of 8 inches. The subsoil is a yellowish fine sand, which becomes whitish at a depth of about 2 feet and then passes into a pinkish sand underlain by red silty clay at 30 inches or slightly less. In some poorly drained situations the subsoil is bluish or mottled. The topography is level to undulating. Where the slope is sufficient to carry away the surface waters and the clay is not too near the top the drainage is good. Some of the flatter areas are improved by ditching or tiling. The type is seldom droughty, owing to the moisture being held up by the underlying clay. The native timber growth consisted of oak, elm, maple, and some white and Norway pine. The principal crops grown are corn, oats, timothy, and clover, together with some potatoes. The yields are superior to those secured on most other sand types.

Vergennes sand.—The soil consists of about 8 inches of brown or grayish-brown medium sand, overlying a light-brown or yellowish sand. Some coarse sand and fine gravel occur in both soil and subsoil, but is more noticeable in the latter. The topography is flat and terrace like for the most part. On account of the looseness and relatively coarse texture of the subsoil drainage is rather excessive and the type is usually droughty. Its best use is for special crops such as lettuce, radishes, watermelons, cucumbers, etc. It is too light in texture for general farming.

Waukesha sand.—The surface soil is a dark-brown to black sand, 10 to 15 inches deep, becoming lighter in color as depth increases. The subsoil proper is a yellow sand of practically the same texture as the surface soil. Frequently the lower portion of the subsoil contains varying quantities of fine gravel. This type represents sedimentary material resulting from the reworking of glacial till by wind and rushing glacial waters. The topography is usually level to undulating. The soil is well drained, and crops sometimes suffer owing to lack of moisture. Corn, oats, rye, and timothy are the principal crops grown. The yields are generally small and uncertain, being larger in wet than in dry seasons. Vegetables and melons do well.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Plainfield sand	Michigan 5; Wisconsin 3, 5, 6, 7, 10, 11, 15, 16	327,552
Dunkirk sand	Michigan 9; Minnesota 3; North Dakota 8; Ohio 8; Pennsylvania 7; Wisconsin 8.	82,816
Clyde sand	Michigan 1, 2, 3, 7, 8	67,400
Fargo sand	North Dakota 3, 8	51,520
Merrimac sand	New Hampshire 1, 2	44,480
Sioux sand	Minnesota 1; Wisconsin 9, 14	37,696
Waukesha sand	Indiana 6, 7; Iowa 1; Wisconsin 16	36,992
Saugatuck sand	Michigan 1	24,120
Adams sand	New York 5	24,000
Superior sand	Wisconsin 7	14,848
Fox sand	Wisconsin 8	2,368
Vergennes sand	New York 5	1,024
Mankato sand	Missouri 20	448
Chenango sand	New Jersey 2	384
Poygan sand	Wisconsin 8	64
Total		715,712

[1] For key to numbers in this column see p. 733.

GRAVEL PHASE.

The soils of the gravel phase are porous and leachy and of low value for general agricultural purposes, on account of their tendency to droughtiness. They are most advantageously used for the production of early truck and market garden crops which can be matured and harvested before the advent of the dry, late summer season. Some of the favorably situated areas of Dunkirk gravel are used for the early varieties of table grapes and are also fairly well adapted to some of the stone and bush fruits. Fair yields of a good quality of sugar corn and potatoes are secured from both the Dunkirk and Hoosic types.

Dunkirk gravel.—This is a very gravelly soil of old lake beaches several feet in depth, occurring in narrow bands between the lake and uplands. It is composed of waterworn fragments of shale and is quite droughty. This soil in some of the areas is used extensively for the culture of grapes, to the early varieties of which it is well adapted. Peaches, plums, and some of the bush fruits also do well. The soil is not well suited to the general farm crops.

Hoosic gravel.—This soil consists of a mass of small to large gravel and rounded stones, with which there is commingled a varying but usually small percentage of fine-earth material. The surface for a few inches is brown in color, while in the lower depths the color is either a light brown or yellow. The type is a stream deposit from swiftly moving water currents of large volume. The whole section is loose and open and drainage is somewhat excessive. The soil is adapted to corn, potatoes, rye, clover, and alfalfa, though yields are sometimes curtailed by drought.

Area and distribution of the gravels.

Soil name.	State or area.[1]	Acres.
Hoosic gravel	New York 17	31,232
Dunkirk gravel	New York 6, 18; Ohio 1; Pennsylvania 7	8,744
Total		39,976

[1] For key to numbers in this column see p. 733.

GRAVELLY SAND PHASE.

The soils of the gravelly sand phase are open and porous in character and are underlain by subsoils which are still more leachy and unretentive of moisture. Although the topography is usually level to gently undulating, the presence of gravel renders subdrainage so free that the soils are droughty and can not be recommended for the ordinary field crops, except in seasons of abundant and frequent rainfall. On some of the areas, however, potatoes and sugar beets do well. The soils are best adapted to the lighter varieties of truck crops, such as cucumbers, cantaloupes, and melons, and to small fruits.

Clyde gravelly sand.—The surface soil is a medium-textured, light to dark brown loamy sand or light sandy loam, 10 inches deep, carrying a large percentage of gravel. The subsoil is a rather coarse, incoherent gravelly sand, usually grading into a mixture of coarse sand and fine gravel at a depth of from 24 to 30 inches. Clay is often found at from 4 to 8 feet below the surface. The soil is the result of beach or shallow water deposition, in places influenced to some extent by local wash from the higher lands. The topography varies from gentle slopes to gently rolling ridges representing old beach-lines or terraces. The type is generally well drained. Light yields of corn, oats, wheat, rye, timothy, clover, and buckwheat are secured, and some special crops, such as sugar beets, beans, and, potatoes, are grown. The soil is also adapted to fruit and truck crops.

Dunkirk gravelly sand.—The surface soil is a yellowish-brown to brown gravelly sand, about 8 inches in depth. The subsoil to a depth of 3 feet is a gravelly sand, somewhat lighter in color than the underlying beds of stratified sand and gravel. The sand content of both soil and subsoil is largely coarse, medium, and fine. Though the gravel content in the soil is variable, it is usually quite high, reaching 50 per cent or more in many typical areas. The type represents beach deposits along old glacial lakes for the most part, though including some terrace material. The soil is well drained. It is best adapted

to such crops as cantaloupes, cucumbers, and other truck crops, and to those crops which must be forced to early maturity. It is too light and loose for general farm crops, except in seasons of considerable rain and when heavily manured.

Vergennes gravelly sand.—The surface soil is a light-brown gravelly sand or gravelly sandy loam, about 6 inches deep, the gravel being small and water-worn. The subsoil is a yellowish-brown or grayish stratified gravelly sand. The topography is slightly rolling to ridgy, where marking old beach lines, though some flat-topped terraces exist. The natural drainage of the type is excessive, so that it is usually droughty. The native timber growth was beech, maple, white pine, hemlock, etc. Poplar is one of the most common second-growth varieties. The type is best adapted to the special crops, such as the lighter truck crops. Corn for ensilage produces fair yields, and good crops of potatoes are secured. Clover also grows well.

Area and distribution of the gravelly sand.

Soil name.	State or area.[1]	Acres.
Dunkirk gravelly sand	Michigan 5, 8; New York 6, 10	32,992
Clyde gravelly sand	Michigan 1, 8	24,656
Vergennes gravelly sand	New York 5	4,672
Total		62,320

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

The coarse sand phase, like the gravelly sand, is too light in texture and its moisture-retaining capacity is too low to be suitable for the growth of long-season crops. Its best use, therefore, is for early-maturing truck and garden crops, and with judicious fertilization good yields can be secured. The topography is level to gently undulating, and where areas of this group of soils occur near centers of population providing ample markets the production of perishable truck and garden crops might be profitably engaged in.

Dunkirk coarse sand.—This type to a depth of 3 feet or more consists of a loose, friable sand of yellowish or brownish color. The surface 10 inches is usually slightly more loamy and darker colored, owing to the incorporation of organic matter by tillage. At depths ranging from 5 to 10 feet and more the sand is underlain by a chocolate-colored clay. The soil is of lacustrine origin and represents glacial débris assorted by the action of water and deposited near the shores of extinct lakes. The surface of the type is usually level, but the drainage is excellent. The type is highly prized for trucking where markets are available, but it is generally considered too droughty for general farming.

Hoosic coarse sand.—The surface soil consists of 4 to 6 inches of coarse sand, light brown in color. The subsoil is of about the same texture, light brown to yellow in color, and extends to a depth of several feet. Some small gravel is frequently encountered over the surface and throughout both soil and subsoil. This type is a delta formation, deposited under glacial lake conditions. The surface is level to gently undulating and the drainage is inclined to be excessive. The soil is little used for agriculture, except for kitchen gardens, but when a sufficient moisture content can be maintained it is adapted to the production of early truck crops, strawberries, and early vine crops.

Merrimac coarse sand.—The surface soil has an average depth of about 8 inches and consists of a yellowish coarse sand to dark-brown coarse loamy sand. The subsoil consists of a yellow coarse sand, usually resting at an average depth of 20 inches on a stratum of water-worn quartz gravel, which is generally white. This gravel sometimes comes within a few inches of the surface, and again is not found within the 3 feet of the profile. Both soil and subsoil are composed largely of coarse and medium sands, with very little of the finer grades, but both often contain a high percentage of gravel. The type occupies terrace areas along stream courses and the surface is quite level. It is of glacial origin, being evidently reworked glacial drift deposited in shallow waters. Very little of this type is cleared. Good yields are secured only in abnormally moist seasons and with heavy fertilization. Beans and potatoes do fairly well, and other light truck crops could be produced by proper fertilization.

Area and distribution of the coarse sand.

Soil name.	State or area.[1]	Acres.
Merrimac coarse sand	Connecticut 1; Massachusetts 1; New Hampshire 1, 2; New York 7; Rhode Island 1.	138,568
Hoosic coarse sand	New York 17	6,080
Dunkirk coarse sand	New York 11	3,200
Total		147,848

[1] For key to numbers in this column see p. 733.

FINE SAND GROUP.

The fine sands constitute the most important group of soils in this Province and in the Northern States are valuable for the production of nearly all kinds of vegetables and truck crops. The range in topographic position, surface contour, and distance above ground water is sufficient to make possible the production of vegetables having a rather wide range in their individual characteristics and requiring a considerable degree of contrast in soil conditions for their growth. The lighter textured, more rolling, and better drained areas of the fine sands are adapted to the lightest types of vegetables, such as lettuce, radishes, cucumbers, asparagus, early peas, and string beans, early potatoes, melons, etc., while the lower lying soils, whose texture is somewhat heavier and which are more retentive of moisture and darker in color, owing to the presence of more organic matter, can be utilized for the production of some of the heavier truck crops which are usually grown on fine sandy loams, loams, or even heavier soils. Under such conditions such crops as sweet corn, tomatoes, cantaloupes, spinach, early cabbage, parsnips, carrots, and salad beets do best. Some of the darker colored, heavier phases would even be found well adapted to celery and onions.

Where soils of this group occur near large bodies of water they are well suited to small fruits, including peaches, plums, cherries, and grapes, and to raspberries, blackberries, and strawberries. Fair yields of some of the ordinary field crops, such as corn, oats, and rye are produced. The best use of the soils of this class, however, is for garden and truck crops and small fruits, and they should be devoted to intensive culture along these lines wherever the market demands will warrant.

Adams fine sand.—The soil is a light-brown fine sand, about 8 inches deep, overlying a yellowish-brown fine sand. Comparatively little coarse sand or gravel is present in the soil section. The type usually occupies terrace, delta, or beach positions and the topography varies from level to rolling, the natural drainage being good to excessive. The soil is, however, not so droughty as the Adams sand. The native vegetation consists of white pine, poplar, birch, and scrub oak, with an undergrowth of huckleberry bushes, sweet fern, and grasses. The soil is adapted to truck crops, such as watermelons, cantaloupes, cucumbers, early peas, early potatoes, etc., and to such small fruits as strawberries. It is not so well suited to general farm crops.

Cancadea fine sand.—The surface soil is a fine to very fine yellow sand, about 10 inches deep. The subsoil is slightly coarser in texture than the surface soil. The type is not largely cultivated, although suited to early truck crops if care be taken to increase and maintain the organic matter content.

Chenango fine sand.—This type is characterized by a light-brown or yellowish-brown fine sand surface soil of fairly uniform texture and about 8 inches deep. The subsoil is usually a yellowish-brown, incoherent fine sand, though in some areas the upper subsoil is rather more compact than the surface. As the depth increases the texture becomes slightly coarser, and a few small, rounded gravel are in some cases present below 24 inches. The topography is level to undulating, or it may be somewhat rolling or dunelike where blown by the wind. The soil is best adapted to the production of early truck crops, including green corn, melons, asparagus, etc.

Clyde fine sand.—The surface soil consists of a dark-gray to black fine sand varying in depth from 4 to 20 inches. The subsoil has about the same texture as the soil, but contains less organic matter and is lighter in color. The type has been formed by the reworking of glacial sands and their deposition in former lakes. The topography is nearly level, and the natural drainage is generally

poor. The soil is greatly improved by artificial drainage. The crop value of this soil depends much upon the proportion of organic matter present and the drainage conditions. It is suited to small fruits, being an ideal soil for strawberries. Fair crops of corn, oats, and potatoes are produced.

Dunkirk fine sand.—The surface soil is a brown to gray or yellow fine sand, varying in depth from a few inches to 1 foot. It is usually quite uniform in texture and contains few stones or gravel. In some cases it is light, while in others it is rather loamy. The subsoil is an orange, gray, or yellow to brown, loose, incoherent fine sand, resembling the surface soil in texture. The type occupies lake-plain lowlands. It sometimes occurs as an ancient lake beach and again as lake sediments redistributed by wind action. A small part of the type occurs as ridges or knolls. It is the result of the reworking and distributing of water-deposited glacial sands. The topography varies from nearly level to rolling. The soil is well adapted to early truck crops, such as melons, tomatoes, and cucumbers. Small fruits also do well. On account of the texture of the soil, it is not suited to general farming.

Fargo fine sand.—The type consists of dark-brown loamy fine sand having an average depth of about 16 inches, beneath which is found a yellow loamy fine sand. There are no stones or gravel in either soil or subsoil. There are, however, occasional wet and sloughlike places of small extent, where the soil is considerably heavier than the average of the type. The soil occupies level to gently rolling areas. It is a delta deposit of glacial material carried into preexisting lakes. A very large proportion of the type is yet unbroken, being utilized chiefly for the production of wild hay. Wheat, flax, and wild hay are the principal crops grown upon the areas of the type so far mapped. When well drained it should be a very good soil for potatoes, canning crops, and small fruits. It is, however, better adapted to stock raising or dairying.

Fox fine sand.—The surface soil is a light-brown fine sand, usually loose, incoherent, and free from gravel and stones. The subsoil consists of a yellowish fine sand, loose and incoherent in texture, and becoming pale yellow in color with depth. The subsoil contains lenses and thin beds of stratified gravel, and occasionally heavy beds of gravel may be encountered within the 3-foot section. The type may occur either as a glacial outwash area or as a terrace along a glacial stream valley or an existing stream within or flowing from the glacial region. The topography is level, pitted, or, in rare cases, rolling, owing to erosion. The type is usually well drained. It is naturally deficient in organic matter, but when liberal quantities of stable manure are applied or green crops are turned under fair yields of corn, potatoes, and early vegetables can be secured.

Hoosic fine sand.—The surface soil consists of a light-brown fine sand, with an average depth of 7 inches. The subsoil is a very light-brown to yellow fine sand, 3 feet or more in depth. The origin of the type is alluvial, in delta or high-terrace forms of former flood deposits. It is adapted to early truck crops, corn, rye, potatoes, and clover.

Manchester fine sand.—The soil is a dark fine sand, about 8 inches deep, underlain at about 20 inches by medium sand resting on glacial till, which is generally derived from red Triassic sandstone. The surface is slightly rolling and has been modified to a slight extent by wind action. Where the subsoil is not too deep the type is retentive of moisture and fair crops of truck, grains, and tobacco are produced.

Newton fine sand.—The soil consists of a light-gray to yellowish fine sand, which is underlain at depths varying from 10 to 36 inches by interstratified layers of peat and black fine sand. The type has probably been formed by the deposition of a layer of light-colored fine sand over the black fine sand, which gives rise to the Clyde fine sand. The surface is generally level, although somewhat broken by ponds and swampy depressions. Much of the type supports a growth of water-loving grasses, willow, and birch, and its chief use is for pasture.

Orono fine sand.—This soil is a loose, incoherent fine sand, several feet deep. The first 7 to 10 inches is very light-brown in color, and the subsoil is pale yellowish-brown, becoming gray with depth. The type is derived from glacial sands deposited by water currents as terraces and deltas. The porous subsoil affords excessive drainage. The surface is rolling to sharply undulating. The type is droughty and not a strong general farming soil, but can be well adapted to garden vegetables and early truck crops.

Plainfield fine sand.—The surface soil is a light-brown or grayish-brown, loose, incoherent fine sand about 10 inches deep, in which a small percentage

of fine gravel is sometimes found. The subsoil is lighter in color and a fine sand in texture. but contains varying quantities of small, waterworn gravel, frequently stratified. The type is derived from glacial outwash or valley fill, the material being deposited either in broad outwash aprons or as high terraces along present or abandoned stream channels. The topography is flat to gently undulating. On account of the porosity of the subsoil and the underlying beds of gravel drainage is excessive, and the type is droughty and not well suited to any but the lighter general farm crops, such as rye and potatoes or early vegetables, melons, etc.

Vergennes fine sand.—The surface soil consists of a dark-brown, black, or yellow loamy fine sand, from 6 to 10 inches deep. The subsoil is a light-brown or yellow medium sand, resting upon the basal clays of the region at depths ranging from 3 to 4 feet, though in rare instances the sandy material may be 6 feet or more in depth. Small quantities of gravel are frequently found in both soil and subsoil. This type is a lacustrine deposit, more or less modified by recent stream action. It is quite varied in surface features, occurring in level areas, along slopes, and among foothills, and for the most part is well drained. The soil is probably best adapted to truck crops and small fruits, though corn, oats, and hay are grown with fair success.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Dunkirk fine sand	Indiana 1, 7; Michigan 5, 8; New York 1, 6, 8, 9, 10, 12, 13, 14; Pennsylvania 7; Wisconsin 10.	225,152
Fargo fine sand	North Dakota 8, 9	164,160
Clyde fine sand	Indiana 7; New York 5, 6, 9, 13; Wisconsin 3, 4	66,624
Manchester fine sand	Connecticut 1; Massachusetts 1	46,462
Vergennes fine sand	New York 5, 16; Vermont 1	33,344
Plainfield fine sand	Wisconsin 3, 7	22,912
Adams fine sand	New York 5	21,248
Fox fine sand	Wisconsin 3	9,344
Hoosic fine sand	New York 17	7,168
Newton fine sand	Indiana 7	5,888
Orono fine sand	Maine 2	3,264
Caneadea fine sand	New York 6	1,024
Chenango fine sand	New Jersey 2	512
Total		607,102

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

The sandy loam group comprises soils of friable structure which are easily worked. As a rule, the subsoils are sufficiently retentive of moisture for the maturity of many of the ordinary field crops, at least in years of rather more than normal rainfall. Even in relatively dry seasons some of the intertilled crops can be grown with fair success by the practice of frequent cultivation so as to form and preserve a dust mulch at the surface which will lessen the evaporation. Under ordinary methods of cultivation corn, oats, wheat, rye, potatoes, and some clover and timothy are grown. Alfalfa and sugar beets have also given good results in some localities and are field crops in one of the Wisconsin areas and in the Connecticut Valley. This group is the lightest textured one on which the general crops can be grown. and it is most valuable for early maturing special crops, such as tomatoes, cantaloupes, early potatoes, sweet corn, string beans, peas, etc., and for the small fruits, especially strawberries, raspberries, and blackberries. Such tree fruits as peaches are well suited on this class of soils, though the texture, especially of the subsoil, is rather too light for any but the earlier. more perishable varieties of apples.

The Sioux sandy loam has the most extensive acreage of any of the sandy loams of the group and it and the Superior and Fargo are widely used for the general farm crops, while the types on which special and truck crops are most profitably developed are the Dunkirk and Clyde sandy loams. Both of these latter soils are well situated, both with respect to topography and to geography, for their best economical use for truck and market-garden products. They also contain a higher percentage of organic matter and are less subject to drought than the Chenango, Hoosic, and some of the other members of the group.

Taking the group as a whole, better success may be expected with truck and special crops than with the staple farm crops.

Chenango sandy loam.—The surface soil of this type is a light-brown sandy loam, about 8 inches deep, overlying a yellowish-brown somewhat incoherent sandy loam or loamy sand. Small gravel is found at the surface and in the subsoil. The type occupies stream terraces above overflow and is well suited to the production of truck crops and small fruits.

Clyde sandy loam.—The surface soil is a dark-gray or brown medium-textured sandy loam, from 8 to 12 inches deep, resting on material of similar texture but lighter color, which is underlain at lower depths by a drab or brownish mottled sandy clay, sometimes tending more toward a sticky sandy loam. The soil carries a fair percentage of organic matter and is easily brought into good tilth. The type has been formed by the reworking of glacial material as beach or shallow-water deposits. The surface is level to gently rolling, and upon the whole the drainage features are fairly good. This is a good soil for general farm crops, sugar beets, beans, potatoes, and orchard fruits.

Dunkirk sandy loam.—The surface soil consists of a brown sandy loam about 10 inches deep, which is underlain to a depth of 3 feet or more by lighter colored sandy loam, sometimes containing fine gravel. This type is derived from glacial material reworked under stream and wave action. The topography is undulating to gently rolling. Drainage is always good and sometimes excessive. This is not an especially good soil for general agriculture, but is well adapted to truck and garden crops, especially cabbage, tomatoes, cucumbers, potatoes, etc.

Fargo sandy loam.—The soil is a dark-brown fine sandy loam, 18 inches deep, underlain to a depth of 2 feet by a yellowish fine sandy loam, below which is a grayish-yellow silt loam extending to a depth of 3 feet. Gravel is often present in both soil and subsoil. The type occurs along the border of glacial lakes and is composed of reworked glacial material. The surface features vary from undulating to broken, and the natural drainage is usually good. This soil is devoted to all of the general farm crops of the region, though the yields are generally light. It is a safe soil for corn under the usual variations of the climate.

Fox sandy loam.—The surface soil is a light-brown or grayish medium sandy loam, 8 inches deep, having a loose structure and containing only a small proportion of organic matter. The subsoil is a yellowish-brown or reddish-brown medium sand, which becomes loamy at from 12 to 18 inches. Below 18 inches beds of medium to coarse sand and fine gravel are found. The surface of the type is gently undulating to flat, and on account of the underlying beds of sand and gravel and the loose structure of the surface soil the natural drainage is excessive. With proper fertilization the type is adapted to truck crops, corn, oats, hay, etc.

Hartford sandy loam.—The surface soil is a dark-brown sandy loam about 1 foot deep. The subsoil to a depth of 3 feet or more is a red or yellow sand or light sandy loam. Medium and fine grains of sand predominate, and the content of coarse sand and gravel is small. The type occurs in broad terraces and plains situated some distance back from the larger streams. It is derived from glacial material laid down in glacial lakes. The topography is usually level, though sometimes slightly rolling and billowy as a result of wind action. The soil is extensively used in the production of truck crops and tobacco. The heavier phase of the type appears to be the best tobacco soil of the Connecticut Valley area, especially for the shaded crop, the leaf being of good quality, light colored, elastic, and of fair body.

Hoosic sandy loam.—The surface soil is a light-brown or yellowish-brown sandy loam, 9 inches deep, containing a small percentage of small, rounded gravel. The subsoil is a yellowish-brown to yellow light-textured sandy loam, in which the proportion of coarse sand and gravel increases with depth. This material is usually stratified below a depth of 3 feet and sometimes lies nearer the surface. The topography is level to gently undulating or slightly rolling, and drainage is apt to be excessive, owing to the porous character of the deeper subsoil. The soil is used for a variety of cultivated crops, though only light yields of the grains and grasses are generally secured. It is best adapted to early green corn, potatoes, and truck crops.

Hudson sandy loam.—The soil to a depth of 8 inches is a light-brown medium sandy loam, underlain by a medium-textured somewhat incoherent yellow sandy loam, which occasionally contains an admixture of gravel. The subsoil is underlain by clay deposits. The type is lacustrine in origin. The surface varies from nearly level to rolling and has good drainage.

Only a small part of this type is in cultivation, though it is a fair soil for all general farm crops and is particularly well adapted to trucking and small fruit.

Manchester sandy loam.—The soil is a reddish or dark-yellow medium sandy or gravelly loam, from 8 to 18 inches in depth, underlain by loamy sand and gravel, frequently containing large bowlders. The type is a combination of glacial lake and stream deposits, and the material is exceedingly irregular in thickness. It is formed in part, especially the subsoil, from the underlying red Triassic rocks. The surface is generally rolling, in the form of ridges and knolls, though the type occasionally occurs as low, flat terraces. The soil is naturally fertile, but the porous subsoil renders it readily subject to drought. It is well adapted to corn.

Mankato sandy loam.—The soil consists of a brown to dark-brown medium fine sandy loam, underlain at an average depth of 15 inches by solid bedrock. Usually 2 or 3 inches of the material directly overlying the bedrock is a reddish-brown fine loam. In some places the soil is 2 feet deep, while in others it is only a few inches deep, and in places the bedrock outcrops. Generally the shallower the soil the more loamy the texture. The underlying rock is either Shakopee limestone or Jordan sandstone. Granitic and gneissic bowlders from 1 to 6 feet or more in diameter are thickly scattered over the surface in some localities, but as a rule do not interfere seriously with cultivation. The type occurs in the form of river terraces. It has been formed by the deposit of a thin layer of sandy material over the underlying rock. It is quite droughty. Light to fair yields of corn and small grains are secured. The soil makes excellent pasture in wet and moderately wet seasons. Where the sand is deepest the soil is quite well adapted to the production of early vegetables.

Merrimac sandy loam.—The surface soil is a brown sandy loam, about 8 inches deep, often containing small quantities of fine gravel. The subsoil is a light-brown sandy loam, becoming less coherent with depth, and at about 20 inches passing into a yellowish-gray coarser sandy loam, more or less interstratified with fine gravel, extending to variable depths. The type occupies level to gently undulating or more or less pitted topography, occurring as kame deposits and filled-in valleys. The drainage is good. Corn and grass are the principal farm crops, though the type is also well adapted to potatoes and vegetables, as well as fruits.

Plainfield sandy loam.—The surface soil is a brown loamy sand to sandy loam, 16 to 18 inches deep. The subsoil becomes lighter in color and somewhat coarser in texture as depth increases, and at about 30 inches is usually a yellow sand, possessing but little coherency. For the most part the material has been laid down by rushing glacial waters and occurs in broad, filled-in valleys along the streams and as glacial outwash in the glaciated region of the Great Lakes, and also in the Driftless area of Wisconsin. The type presents a level to only slightly undulating topography and the material often extends to many feet in depth. While subirrigated, the soil is now above all overflow. It produces light yields of corn, hay, rye, and some of the other general farm crops. Dairying is an important industry on some areas of the type.

Sioux sandy loam.—The surface soil is a coarse to medium brown sandy loam or heavy sandy loam, from 10 to 24 inches deep, containing considerable organic matter. The color becomes lighter with depth. The subsoil over wide areas consists of almost pure water-worn gravel, which is found at an average of 22 inches below the surface and extends to great depths. The subsoil varies considerably, however, and the gravel is frequently bedded in a matrix of sandy loam, silty sand, or sand. This is an alluvial type, occupying river terraces, with level to gently rolling topography. The drainage is too thorough for good crop yields where the pure gravel subsoil predominates, although the soil is early and might be profitably utilized in the production of early, short-season crops. Hay, corn, oats, and alfalfa are important crops, but the yields are very irregular. In a wet season or on areas of better moisture conditions 40 to 60 bushels of corn are obtained per acre, but a dry spell at the critical period of growth often results in total failure. Some truck is grown. Clover and timothy have been produced with fair success.

Superior sandy loam.—The surface soil is gray to reddish sand or light sandy loam of medium texture, varying in depth from 1 to 2 feet. Sometimes the surface is strewn with small rocks and bowlders in such quantities as to interfere with cultivation. The subsoil is a stiff, tenacious, impervious red clay, similar to the material forming the Superior clay, and is sometimes inter-

stratified with thin layers of fine sand. The sandy soil is the result of wash from higher lying sandy land. The type usually occupies level and gently rolling areas with sufficient elevation to secure good natural drainage. It is a warm soil, easily tilled, and adapted to a variety of crops, including medium late vegetables for midsummer and fall markets. The crops grown are clover, timothy, potatoes, and small fruits. The original timber growth is pine.

Tuscarora sandy loam.—The surface soil is a gray to brown mellow sandy loam, about 8 inches in depth. The subsoil is a yellow to gray sandy loam to a depth of 30 inches. Below this there occurs a deep, dense clay subsoil, causing poor drainage conditions. This type is best adapted to the production of hay and for permanent pastures.

Vergennes sandy loam.—The soil is a black or dark-brown medium to fine sandy loam, from 8 to 12 inches deep. The surface soil does not differ materially in texture from that of the Vergennes fine sand, but the subsoil is a drab clay loam or clay. In a few places the typical soil is underlain at an average depth of a foot by a layer of medium sand, which rests directly upon the heavy underlying clay. In low-lying areas the soil is derived from late sedimentary deposits overlying the Champlain clays; other areas are either colluvial material or shore deposits overlying the Champlain clays. In topography the type is either level or rolling, being marked sometimes by hummocks and low swells. For the most part it is well drained. The soil is adapted to corn, clover, and late truck crops.

Walcott sandy loam.—This type is composed of various phases of soil, but in general the surface soil ranges from a grayish to brownish sandy loam, with an average depth of about 8 to 10 inches, while the subsoil to a depth of 3 feet or more varies from a sand to a sandy clay of yellowish color. Sometimes small sand dunes from 1 to 2 feet high occur, and in such cases the type is sandier. Aside from the low sand dunes, the surface of the type is level, and there are considerable areas which are poorly drained and uncultivated. The type is derived largely from light, sandy material blown from the adjacent areas of Fargo fine sand and spread out over the heavier lacustrine types to the eastward. It is devoted largely to prairie hay and pasturage.

Waukesha sandy loam.—The surface soil is a dark-brown to black sandy loam of loose structure extending to an average depth of 1 foot. It contains only a small proportion of fine gravel. The subsoil to a depth of about 24 to 30 inches is a yellowish gravelly sandy loam, the gravel content being fine and not infrequently including small, rounded cobbles. The deep subsoil is a light-yellowish, heavy, gravelly sandy loam or gravelly clay. The type occurs both in broad extensive valley fills and as outwash plains and narrower intermorainic filled-in valleys. It is derived from reworked glacial material deposited by rushing glacial waters. The topography is level to gently undulating. On account of the porous nature of the subsoil, drainage is often excessive and crops frequently suffer from drought, except in relatively wet seasons. Under favorable moisture conditions good crops of corn, rye, hay, and potatoes are secured.

Williston sandy loam.—The soil consists of a dark-brown, medium to fine, light-textured sandy loam, underlain at an average depth of 2 feet by a whitish loam or sandy loam. The type is probably mainly reworked glacial material. It occupies high-lying stream terraces and probably once composed part of the flood-plain of a swollen glacial stream. In seasons of average rainfall good crops are secured. Wheat yields 25 bushels and flax 20 bushels to the acre in good seasons.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Sioux sandy loam	Indiana 3, 10; Iowa 1; Minnesota 4, 5; Missouri 14; South Dakota 2; Wisconsin 6, 14.	141,056
Clyde sandy loam	Indiana 3; Michigan 2, 5, 8; Pennsylvania 7; Wisconsin 15	126,400
Waukesha sandy loam	Indiana 6; Wisconsin 11, 16	118,848
Superior sandy loam	Wisconsin 1, 13, 16	103,488
Hartford sandy loam	Connecticut 1; Massachusetts 1	95,304
Dunkirk sandy loam	Indiana 1; Michigan 9; New York 11, 12, 13; Ohio 8, 10; Wisconsin 12.	69,632
Merrimac sandy loom	Massachusetts 2	62,400
Fargo sandy loam	North Dakota 9	53,504
Plainfield sandy loam	Illinois 11; Wisconsin 3, 5, 9	46,656
Manchester sandy loam	Connecticut 1; Massachusetts 1	44,160
Hoosic sandy loam	New Jersey 2	5,888
Williston sandy loam	North Dakota 11	3,584
Walcott sandy loam	North Dakota 9	3,264
Mankato sandy loam	Minnesota 1	2,816
Vergennes sandy loam	New York 16; Vermont 1	2,112
Fox sandy loam	Wisconsin 8	2,048
Hudson sandy loam	New York 4	1,856
Chenango sandy loam	Indiana 5; New Jersey 2; Pennsylvania 7	1,728
Tuscarora sandy loam	New York 6	320
Total		885,064

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

This type has been recognized so far in only one of the areas surveyed. In a general way it is much like the stony loam phase, except that it is rather more friable in texture and contains a small quantity of gravel, which makes it better adapted to special than to general farm crops.

Clyde stony sandy loam.—The soil is a dark-brown, medium-textured gravelly sandy loam, 18 to 24 inches deep, underlain by a sandy loam or mottled brown clay loam containing a small percentage of gravel. A noticeable characteristic of the type is the occurrence of bowlders, which are found in large numbers over the surface and to a less extent below the surface. These bowlders are mainly of granite, and range from cobbles to angular fragments 2 or 3 feet in diameter. With these stones removed from the surface, the soil is a good, friable sandy loam and produces fairly good crops. The type is of glacial or lacustrine origin, has level to gently rolling topography, and for the most part is fairly well drained. The crops grown are corn, oats, wheat, sugar beets, beans, potatoes, hay, etc.

Area and distribution of the stony sandy loam.

Soil name.	State or area.[1]	Acres.
Clyde stony sandy loam	Michigan 8	8,000

[1] For key to number in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The soils are light and loose in texture and structure, and are underlain by subsoils which are relatively porous and leachy. They are not, therefore, naturally suited to the production of the heavier farm crops, which require larger stores of moisture for their slow growth and maturity than these soils can retain, although in some locations, where the ground water is near the surface or where the soils are slightly heavier than normal, or in seasons of moderately heavy rainfall, the staple crops are grown with fair success. Some wheat and flax are produced on the Williston gravelly sandy loam, and some of the areas of the Orono, Caneadea, and Dunkirk types give fair yields of corn. Clover and alfalfa are also grown to some extent. The Caneadea and Dunkirk types are well suited to grapes, especially the earlier table varieties, and to blackberries, raspberries, and strawberries, while peaches, cherries, and plums give good

yields of fair quality. Where the demands of the market will warrant, the group should be devoted to the growth of special vegetable and fruit crops, rather than to the grains and hay.

Caneadea gravelly sandy loam.—The surface soil is a light gravelly sandy loam, brown to yellowish brown in color. The subsoil is a yellowish-brown to yellow sandy loam. The sand content of both soil and subsoil is medium to fine in texture. Gravel is abundant but generally small in size. This soil type is adapted to the production of early potatoes, vine crops, and berries.

Chenango gravelly sandy loam.—The soil is a light-brown to slightly yellowish brown gravelly sandy loam, about 8 inches deep, overlying a subsoil of yellowish brown to yellow gravelly sandy loam or gravelly sand. At the surface and throughout the subsoil a small quantity of water-worn gravel is found, while within or immediately underlying the 3-foot section occur beds of stratified sands and gravel. The type occurs as glacial terraces and is above ordinary overflow. The topography is level to gently undulating, or somewhat hummocky and rolling where kame material is developed.

The drainage is apt to be excessive, on account of the porous character of the subsoil, and the type is rather droughty. The soil is adapted to the market garden and truck crops, but is too uncertain for general farm crops.

Dunkirk gravelly sandy loam.—The soil is a sandy loam, containing from 40 to 60 per cent of small gravel, consisting principally of water-worn shale fragments, and is underlain at about 3 feet by shale fragments or sand. The type represents reworked glacial material deposited in water along the foot of low ridges on lake forelands and also as terraces in stream valleys. It is well drained and early, and is adapted to market-garden and truck crops. It is not well suited to most general farming crops, but is a good corn soil. Grapes are successfully grown.

Fargo gravelly sandy loam.—The surface soil consists of about 12 inches of a dark-brown to black loamy sand or light sandy loam, containing a few small gravel and a considerable proportion of organic matter. The sand content is made up of all grades from fine to coarse sand or small gravel, but the medium to fine grades usually predominate. The subsoil is composed of layers of gravel and coarse sand, which often occur in strata of uniform thickness. The gravel particles vary in size from coarse sand to small cobbles several inches in diameter, and the interstitial material consists of various grades of sand. The type is reworked glacial material, and most of it occupies narrow ridges which mark old beaches of Glacial Lake Agassiz. The crop yields vary considerably, according to the amount of rainfall during the growing season. Wheat, oats, flax, barley, and rye are the principal crops grown.

Fox gravelly sandy loam.—The soil is a light-brown gravelly loam or sandy loam, about 8 inches deep, changing to yellowish 2 inches below the surface. The surface is covered with rounded gravel 2 to 3 inches in diameter. This increases with depth, and in the subsoil there is a great quantity of gravel of all sizes. The type occupies terraces above the first bottoms along streams and is marked by rounded knolls with frequent kettle-hole depressions. The slopes are often quite steep and difficult to cultivate, though no large stones or bowlders outcrop. The type lies farther back from the streams than the Fox gravelly loam. It owes its origin to glacial material which has been modified by water action. This material consists chiefly of shale and sandstone with enough limestone to give it the character of a calcareous soil. The soil is so light and porous as to be of little agricultural value and is generally used for pasturage.

Hoosic gravelly sandy loam.—The surface soil consists of a brown gravelly sandy loam, 4 to 6 inches in depth. The subsoil is a light to yellowish-brown gravelly sandy loam of about the same texture. The type occurs as terraces and was formed from materials deposited in glacial lakes. The soil is too light in texture for general farming, but is well adapted under intensive methods of cultivation to early truck crops, such as melons, cucumbers, and small fruits, especially strawberries. On the heavier and less gravelly phase of the type corn, oats, rye, potatoes, and buckwheat may be grown with some success.

Merrimac gravelly sandy loam.—The soil ranges from a gray or light-yellowish, medium-textured sand to a light-brown loamy sand or sandy loam, with an average depth of 12 inches, resting upon gravelly beds composed of rounded, waterworn gravel varying in size from small pebbles to large cobblestones. The interstitial material, of which there is relatively a small quantity, consists generally of coarse, yellow sand. Some fine gravel is encountered in the soil and upon the surface. The type occurs along stream courses and is derived

from reworked glacial drift. The surface is hummocky, being characterized by small hills of gravel with uneven surfaces, alternating with depressions or kettle holes. General farm crops are grown upon the soil, but as a rule it is not a desirable type to cultivate, since the open, leachy nature of the subsoil causes it to be subject to drought. In many cases it is better adapted to the growing of truck than to general farming.

Orono gravelly sandy loam.—The surface soil consists of 8 or 10 inches of a brown gravelly sandy loam. The subsoil is a brownish gray gravelly sandy loam. The content of rounded and waterworn gravel and stones in the soil and subsoil is extremely variable, but the subsoil is usually underlain at from 2 to 6 feet by deep, cross-bedded sands and gravels. This type is derived from stratified drift, deposited, with few exceptions, in the form of eskers. The soil is loose, friable, well drained, and easily tilled, its agricultural value depending largely upon depth of soil over the porous gravels. Individual fields are held in high esteem, while others are poor, because droughty.

Sioux gravelly sandy loam.—The type consists of a dark-brown loam, about 16 inches deep, containing some coarse sand and enough clay to cause it to become somewhat sticky when wet. The subsoil, to a depth of 4 to 6 feet or more, contains a large proportion of fine, well-rounded gravel, which causes the type to be excessively drained and droughty. The topography is level to undulating. Good yields of corn and oats are secured in favorable seasons.

Williston gravelly sandy loam.—The surface soil consists of 12 inches of a brown, very sandy loam, containing a large amount of gravel. The clay content, though small, is sufficient in places to give the soil a sticky character when wet. The subsoil is a very sandy loam, usually loose and incoherent, with about the same proportion of gravel as the soil. The gravel in both soil and subsoil ranges from the finest grades to rounded pebbles one-half inch in diameter. The type is composed of reworked glacial material deposited at an early date as alluvium along stream courses. The topography is level to rolling. The soil is productive and yields good crops of wheat, flax, and rye.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Merrimac gravelly sandy loam	Connecticut 1, 2; Massachusetts 1, 2; New Hampshire 1, 2.	259,412
Dunkirk gravelly sandy loam	New York 6, 10, 12, 13, 15, 18; Ohio 1; Pennsylvania 7.	83,356
Fargo gravelly sandy loam	Minnesota 3	24,448
Fox gravelly sandy loam	New York 4; Wisconsin 8	12,928
Williston gravelly sandy loam	North Dakota 11	12,352
Hoosic gravelly sandy loam	New York 17	8,640
Chenango gravelly sandy loam	New York 3; Pennsylvania 4	7,680
Orono gravelly sandy loam	Maine 2	4,352
Caneadea gravelly sandy loam	New York 6	3,840
Sioux gravelly sandy loam	Wisconsin 9	256
Total		417,264

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

On account of the rather heavy texture of the soil and the immediately underlying subsurface stratum the coarse sandy loam phase is a fairly productive soil for corn, grains, and tobacco. The gravel stratum which forms the lower subsoil provides good underdrainage, and in situations where it approaches nearer than 2 feet of the surface the type is uncertain for general farm crops. Its best use is for truck crops and some of the small fruits.

Merrimac coarse sandy loam.—The soil is a brown sandy loam, 8 or 10 inches deep, underlain to depths varying from about 1 to 2 feet by reddish or yellowish heavy sandy loam. Below this the material is underlain by coarse sand and gravel. The type is lacustrine in origin. The surface varies from level to slightly rolling and the drainage is good. This soil is excellent for all general farm crops, besides being especially adapted to early truck crops and potatoes. Small fruits do well. In the Connecticut Valley it produces large yields of tobacco of good quality.

Area and distribution of the coarse sandy loam.

Soil name.	State or area.[1]	Acres.
Merrimac coarse sandy loam...	Connecticut 1; Massachusetts 1, 2; New York 7; Rhode Island 1.	247,616

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The value of this group of soils for the production of ordinary farm crops is a little higher than that of the fine sandy loams of the Glacial and Loessial province, owing to their more favorable topographic position and because the ground water is generally nearer the surface. The surface is usually level to gently undulating or slightly rolling, and the group includes some areas which require artificial drainage. In general, however, the drainage is adequate, though the water table is high enough to afford sufficient moisture for the maturity of many of the ordinary farm crops during any but the driest seasons. The yields of the grain and grass crops are not, however, as high as on heavier textured soils. Upon the rather heavy textured Fargo fine sandy loam such crops as wheat, oats, barley, flax, and millet give good yields, and these crops, as well as ensilage crops, clover, alsike, buckwheat, hops, potatoes, and tobacco are successfully grown on the Dunkirk fine sandy loam. Some sugar beets are produced on the Clyde member of the group, in addition to the crops mentioned. Nearly all of the soils of the group, particularly in the eastern regions, are suited to such fruits as peaches, plums, cherries, and even apples. Probably the highest usefulness of this group of soils is in the production of the heavier types of truck and market vegetables, including tomatoes, cabbage, cucumbers for pickling, corn, peas, and other crops for canning, and small vine and bush fruits, including strawberries, raspberries, blackberries, and currants. The earlier varieties of grapes also do well in favored locations on the Dunkirk type.

Benoit fine sandy loam.—The surface soil consists of a dark-brown to black fine sandy loam, with an average depth of 12 to 15 inches. It contains a relatively large quantity of organic matter, and a few small bowlders are sometimes encountered scattered over the surface. This surface material grades into a subsoil consisting of a gray to yellow sandy loam, becoming lighter in texture as the depth increases, until at 25 to 30 inches it is a yellow to gray fine sand, containing gravel and small cobbles. This subsoil is underlain by beds of gravel, which usually occur at a depth of 30 to 36 inches, but are sometimes encountered nearer the surface. The type occupies low basinlike depressions, which occur between or adjacent to small ridges. It owes its origin to glacial drift which has been modified by the action of the waters of Glacial Lake Agassiz. A part of the fine sand in the surface soil has probably been washed down from the adjoining sandy ridges. The surface of the type as a whole is gently undulating. A large part of it is poorly drained.

Only a very small part of the type is under cultivation, the greater proportion being used for hay meadows and as pasture land. The better-drained areas are not productive during dry seasons, and during rainy seasons the greater part of the type is too wet and poorly drained to be of much agricultural value.

Chenango fine sandy loam.—The surface soil is a light-brown or yellowish-brown fine sandy loam, 8 inches in depth, containing some coarser material. The subsoil is a yellowish fine sandy loam, becoming gradually coarser in texture with depth, and contains a small proportion of fine gravel. The topography varies from level to somewhat undulating. The surface drainage is improved in some places by ditching and tiling, but the relative porosity of the subsoil is usually sufficient to take care of excess water. The type has a higher value for general farm crops than the Chenango sandy loam and fair to excellent yields of corn, oats, rye, potatoes, and hay are secured.

Clyde fine sandy loam.—The surface soil is 9 to 12 inches in depth and varies from very fine sand to fine sandy loam of a brownish-gray or brown color, homogeneous in texture, friable, and easily kept in good tilth. The subsoil is a brown or yellow fine sand or fine sandy loam to a depth of 2 feet or more overlying a clay similar to the subsoil of the Clyde loam. Both soil and subsoil are

entirely devoid of gravel. Portions of the type seem to be the result of delta formations subsequently modified by wind and wave action, while other portions occur in the form of low ridges as wind-blown beach deposits. The surface is slightly undulating to rolling, and drainage varies considerably with local topography. Besides general farming and dairying, the production of sugar beets, beans, and potatoes are important interests, and to a less extent the growing of chickory, apples, pears, grapes, and vegetables.

Dunkirk fine sandy loam.—The soil is a gray or light-brown fine sandy loam to a depth of about 10 inches, underlain by a yellowish fine sandy loam or fine sand. It occurs on lake forelands and to a lesser extent as terraces along some of the larger streams. It is for the most part of lacustrine origin. The surface is gently rolling to hummocky. Parts of the type have been influenced by wind action. The drainage is usually good, except in local areas of depression. The soil is adapted to grapes and is also fair grass land.

Fargo fine sandy loam.—The surface soil consists of a dark-brown to black very fine sandy loam, having a depth varying from 8 to 24 inches. The content of organic material in the first few inches is often high. Enough silt and clay are frequently present to render the soil slightly sticky under certain moisture conditions. The subsoil is a grayish, brownish, or yellowish fine sandy loam to a depth of from 2 to 3 feet. The lower portion is often of the nature of quicksand. The type is of lacustrine origin. The topography is level or very gently rolling.

When well drained this soil yields good crops of corn and fair crops of grain, particularly barley. Potatoes, flax, buckwheat, rye, and wheat will do well with good drainage. Some heavy yields of hay are produced. Much of the type is covered with native grasses and for this reason it is largely used for pasture. When properly drained it should be well adapted to the production of onions and celery.

Fox fine sandy loam.—The surface soil of the Fox fine sandy loam is brown to gray in color, a fine sandy loam in texture, and in places somewhat sticky when wet. The subsoil is lighter in color than the soil and at the top has the same texture, becoming heavier with depth. At 24 inches it is a fine sandy clay, below which it becomes lighter, a bed of fine sand often being encountered within the 3-foot section. There is always a substratum of gravel containing at least 25 per cent of limestone pebbles. This type may occur as a glacial outwash plain or a glacial stream terrace. The surface is level or pitted, and sometimes slightly rolling, owing to erosion. The gravelly substratum insures good underdrainage. With sufficient fertilization, the type is fairly productive of the general farm crops, such as corn and small grains, as well as vegetables and some fruits, especially in moist seasons.

Hudson fine sandy loam.—The surface soil is a light-brown or dark-brown silty fine sandy loam 8 inches deep. The subsoil is lighter colored and more compact than the surface soil and is underlain by beds of clay. This type occurs as hilly to rolling and sometimes level areas, with good natural drainage, and is of lacustrine origin. The soil is particularly well adapted to truck crops, apples, pears, and small fruits.

Lidgerwood fine sandy loam.—The soil consists of about 18 inches of a brown or dark-brown fine sandy loam, underlain to a depth of 3 feet by a light-brown medium sand frequently mottled with gray and reddish spots. The type occurs in the bottoms and on the bordering slopes and low hills of the glacial water courses and consists of reworked glacial material deposited during glacial times. The topography varies from nearly level to rolling, and the drainage is usually good. The soil is well adapted to potatoes and truck crops and is a fair type for general farming.

Lockport fine sandy loam.—This soil is a reddish-brown to Indian-red, friable fine sandy loam or light loam, about 9 inches deep, underlain by a subsoil of dark reddish brown to Indian-red color. Scattered through the soil and subsoil are found varying quantities of broken, angular fragments of Medina sandstone, but not sufficient to interfere with cultivation. A small percentage of glacial gravel is also present. The topography varies from nearly level to slightly rolling. The natural drainage is usually poor. The native timber growth on this type consists of elm, beech, hemlock, cherry, maple, and locust. When drained the soil is adapted to the production of apples, pears, quinces, and many small fruits and bush fruits. Ordinary farm crops also yield well.

Merrimac fine sandy loam.—The surface soil consists of a light-brown fine sandy loam extending to an average depth of 8 inches. The subsoil is a yellow fine sandy loam, grading into yellow fine sand, and usually rests upon gravel at

a depth of 3 feet or more. This type occurs as narrow terraces along the river and represents glacial flood-plains deposits. It lies at 10 to 50 feet above the level of the river. Grass for pasturage and hay constitutes the principal crop, though early truck crops for local supply are profitably grown.

Orono fine sandy loam.—The soil is a grayish-brown, incoherent fine sandy loam to a depth of 8 inches, underlain to a depth of 20 inches by a mottled brown and gray fine sandy loam, with a thin layer of hardpan in places at a depth of 18 inches. Stiff blue clay is encountered at about 30 inches. The type is derived from the stratified drift formation. The surface is flat and the soil is poorly drained. It is a poor soil in its natural, undrained condition, but can be made a good general farming soil by thorough underdrainage.

Plainfield fine sandy loam.—The surface soil varies from yellowish to brownish in color, and in texture is a fine sandy loam, extending to a depth of about 10 inches. The subsoil is generally somewhat looser and coarser than the overlying soil and small gravel is usually present. The type occurs as nearly level to gently undulating outwash plains, the materials forming which are often many feet in depth. The underdrainage is thus free. In seasons of a moderate amount of moisture the type produces fair crops of potatoes, corn, and the general farm crops.

Poygan fine sandy loam.—The surface soil is dark-brown to black in color and extends to a depth of 12 inches. The subsoil is reddish brown down to about 26 inches, below which it is red. The texture of the surface soil is a fine sandy loam, of the upper part of the subsoil a sandy clay, and of the deeper subsoil a clay. The reddish-brown sandy clay subsoil is not always present, and when absent the red clay makes up the whole of the subsoil. The type is derived from glacial lake deposits. The topography is level to undulating.

Sioux fine sandy loam.—The surface soil is a dark-gray or black fine sandy loam, from 10 to 15 inches deep, containing a relatively high percentage of organic matter. The subsoil is a fine to medium sandy loam of a light-brown color. At from 3 to 8 feet below the surface the material changes to sand and gravel. This type is of alluvial origin, and occupies both river bottoms and terraces, but is generally confined to the latter. The surface is generally level. The soil generally maintains a good supply of moisture, although in areas of light rainfall irrigation is desirable. The drainage is, on the whole, satisfactory, artificial drains being necessary only in depressed areas. This is a desirable soil, yielding 15 to 35 bushels of wheat, 25 to 50 bushels of corn, 15 to 60 bushels of oats, about 40 bushels of barley, and 20 bushels of flax per acre. Alfalfa grows well, and sugar beets give yields ranging from 8 to 18 tons per acre. On low-lying areas considerable hay is made from wild grasses.

Superior fine sandy loam.—This type consists of a grayish-brown or brown fine sandy loam to a depth of 10 to 16 inches, overlying a lighter colored subsoil. At varying depths the characteristic red or pinkish-red heavy silty clay is encountered, extending to a depth of several feet. The topography varies from level to gently rolling, the sandy loam soil being found deeper on the uneven than on the flat land. The drainage is generally good, except in the lower, flat, or depressed areas, where there is sufficient run-off and the subsoil is near the surface. The native vegetation consisted of oak, maple, and pine, with ash on some of the poorly drained portions. Corn, oats, barley, hay, and tobacco are grown.

Vergennes fine sandy loam.—The surface soil is a grayish-brown to brown fine sandy loam, 8 to 12 inches deep. A small quantity of coarse sand and gravel is present in some instances. The subsoil is a light-brown to yellowish-brown heavy fine sandy loam, though it is often found to grade into a looser, coarser material in the lower part of the profile. The soil is mellow, friable, and easily cultivated. The topography is level to gently rolling, the type usually occupying broad, flat terraces. Though surface run-off is sometimes insufficient, the porosity of the subsoil renders the type well drained. The native timber growth is maple, beech, and other hardwoods. Corn, oats, and hay are the principal farm crops, with some peas and spinach for canning purposes.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Fargo fine sandy loam	Minnesota 1, 3; North Dakota 3, 4, 8, 9	432,384
Dunkirk fine sandy loam	Indiana 1; New York 6, 8, 9, 10, 11, 12, 13, 14, 15, 18; Ohio 1, 3; Pennsylvania 7; Wisconsin 12.	266,698
Clyde fine sandy loam	Indiana 1; Michigan 6, 8; New York 5, 9, 10, 12; North Dakota 1; Wisconsin 3, 12.	103,936
Merrimac fine sandy loam	Connecticut 2; Massachusetts 2; New Hampshire 2	26,432
Sioux fine sandy loam	Minnesota 5; North Dakota 5; Wisconsin 9	11,520
Plainfield fine sandy loam	Wisconsin 3, 15, 16	10,752
Lidgerwood fine sandy loam	North Dakota 9	10,048
Hudson fine sandy loam	New York 4	6,400
Lockport fine sandy loam	New York 10	4,096
Benoit fine sandy loam	Minnesota 3	4,032
Vergennes fine sandy loam	New York 5	3,392
Chenango fine sandy loam	New Jersey 2; New York 3	3,072
Superior fine sandy loam	Wisconsin 7, 10	2,752
Fox fine sandy loam	Wisconsin 3	704
Orono fine sandy loam	Maine 2	640
Poygan fine sandy loam	Wisconsin 4	320
Total		887,178

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

Hartford very fine sandy loam.—The type consists of 10 inches of dark-brown very fine sandy loam, underlain to 3 feet or more by a yellowish silty fine sand. More or less finely divided mica occurs in both soil and subsoil. This soil occurs principally as flat or slightly undulating first and second bottoms along rivers and large streams. The drainage is usually good. The type is known as a strong, safe, and productive soil for this texture. It is particularly well adapted to corn, potatoes, and cabbage. It is the most desirable soil in the Connecticut Valley for broadleaf tobacco.

Area and distribution of the very fine sandy loams.

Soil name.	State or area.[1]	Acres.
Hartford very fine sandy loam	Connecticut 1; Massachusetts 1	17,284

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loams have the widest distribution of any soils in this province, and they are the most valuable for general agriculture, their large water-holding capacity and intermediate texture fitting them for the production of a wide variety of field crops, as well as many special truck and canning crops. The Clyde, Dunkirk, and Fargo are the principal types in the group.

The Clyde loam contains large quantities of organic matter, and where well drained it is a strong soil for general crops, including corn, wheat, oats, and hay, although its special adaptability lies in the production of sugar beets, of which large yields of good quality are secured. The Dunkirk type yields heavy crops of corn and small grains, as well as clover, timothy, and some alfalfa hay, while potatoes, field beans, and hops form subordinate crops in certain sections of New York State. The Fargo loam is one of the best soils of the Middle West for grains, including corn, wheat, oats, barley, flax, and millet, while potatoes do well in some areas. Besides being well suited to the ordinary farm crops, the loams form one of the most important groups for the production of staple heavy truck crops for late markets and storage for winter supplies. Cabbage, tomatoes for canning, carrots, turnips, table beets, and other root crops yield well, especially on the Clyde and Dunkirk types, while on the latter a marked adaptation to apples is evidenced along the Ontario

shore line in New York State. Cherries, plums, pears, the smaller bush fruits, and strawberries also do well.

Bearden loam.—The soil is a dark loam from 14 to 20 inches deep, underlain by a gray or sometimes yellow loam or silty loam. Fragments of shale are frequently encountered and from 3 to 6 feet below the surface a water-bearing sand is often found. Generally the soil is entirely free from stones and gravel, but in some small areas glacial bowlders are seen. This type is composed of reworked glacial material. The topography is fairly level and nearly all of the type is sufficiently well drained to produce good crops. At present it is devoted chiefly to small grains, flax, and wild hay. In the best-drained portions alfalfa might be made to grow.

Caneadea loam.—The surface soil is a mellow loam, yellowish-brown in color to a depth of 8 or 10 inches. The subsoil to a depth of 3 feet is a light loam. There is always a considerable percentage of shale and fine-grained sandstone fragments, with some rounded gravel, in both soil and subsoil. This soil is adapted to general farm crops. Potatoes, vine crops, and berries are especially suited to it.

Chapman loam.—This type is quite variable in character. A striking characteristic is seen in the hummocky surface. These hummocks, with a diameter of 4 or 5 feet and an elevation of a foot or two above the intervening depressions, consist, for the most part, of a bright-yellow to brown, rather coarse loam, which is sometimes gravelly, though usually free from larger stones. At about 12 inches a sticky loam somewhat lighter in color is encountered. This becomes heavier with depth and at from 24 to 30 inches grades into the compact silt loam or silty loam of the lower till. On other mounds the unweathered whitish till is found at the surface, while in still other cases the soil may consist of a light to yellowish-gray silty loam, mottled with brown iron stains. In the depressions the material may consist of a grayish silt loam, similar to the lower till, covered with 6 to 8 inches of vegetable mold, or there may be merely a mass of rocks, underlain by the grayish lower till. The type occupies low country about the source of some of the streams or along their courses. It is of glacial origin. Some of it, locally known as "blueberry bog," supports a thick growth of blueberry bushes, alder, moss, etc. The better-drained portions produce fair yields of grass and grain.

Chenango loam.—The soil is a light-brown or reddish-brown loam, about 8 inches deep, underlain by a somewhat lighter colored and occasionally mottled loam or silty loam. Fine shale fragments and rounded gravel occur in the soil and subsoil. The type occurs on stream terraces, and by reason of the gravel in the subsoil is usually well drained. The flatter areas are sometimes improved by tiling. This is a good soil for general farm crops, as well as for cabbage, potatoes, and, where topographic and climatic conditions are suitable, fruit.

Clyde loam.—The soil ranges from a moderately friable loam to a rather heavy, compact loam of a dark-gray, brown, or black color, from 8 to 12 inches deep, resting upon a drab-colored sandy or silty clay, somewhat streaked and mottled with iron stains. On account of former inadequate drainage, much of the soil is still in a puddled and compact state, sticky and impervious when wet, and very hard when cultivated only a short time. In its natural state, the soil possesses marked clayey properties to within a few inches of the surface, where there is an accumulation of organic matter. In the better-drained areas the soil is mellow, and the subsoil is more friable and pervious to water. The type is derived from glacial lake deposits that have not been modified to any extent by subsequent stream action. Its almost level surface, with occasional low knolls and swells and intervening shallow depressions, naturally causes poor drainage. When properly drained and cultivated large crop yields are secured. The principal crops grown are corn, oats, wheat, hay, and sugar beets. It is considered an excellent soil for the latter crop. It is also an excellent soil for canning crops and late cabbage. Some fruit is also grown.

Dunkirk loam.—The surface soil is a light or dark brown loam, 10 inches deep, generally containing considerable sand, which renders it easy to cultivate. The subsoil is a yellow or light-brown fine sandy loam, usually rather compact, becoming darker in color and heavier in texture with depth. A small quantity of stone occurs in soil and subsoil, but seldom enough to interfere with tillage. The type is derived from glacial material, probably in part reworked with residual soil derived from sandstone and arenaceous shale. The surface is undulating and usually well drained. The soil is desirable for general farm purposes, producing good yields of corn, oats, barley, buckwheat, and potatoes. Fruit, especially apples and pears, and most vegetables do well on this soil.

Elmwood loam.—This soil is a dark-brown fine sandy loam, 2 feet in depth, overlying a close, poorly drained clay. It occupies level terraces along the Connecticut River and is a lacustrine deposit. The type has a rather low present agricultural value, on account of its compact nature and poor underdrainage. Some areas produce small fruits, and some general farm crops are grown, yields of corn, wheat, rye, and hay being moderate.

Fargo loam.—The soil is a black loam to a depth of 10 to 12 inches, underlain to about 3 feet by a heavier yellowish or drab loam. Occasionally there are layers of sand below 2 feet. The type has been formed from reworked glacial material. It occurs as low, flat areas, with no drainage channels, and a large part of it is too wet for cultivation, being left in native prairie and slough grasses. The better drained portions produce some timothy and prairie grass. If well drained, this soil should produce wheat, oats, and flax with success, besides being an excellent grass land.

Fox loam.—The soil is a gravelly dark-brown loam or silty loam to a depth of from 8 to 12 inches, underlain by a gravelly material of lighter color, changing to yellowish at about 2 feet, where it rests on a gravelly or sandy substratum. Occasionally a little rounded gravel is found upon the surface. This material consists chiefly of shale and sandstone, with enough limestone to give it the character of a calcareous soil. The type occurs on gravelly terraces above overflow, though some areas of depression are wet enough to require drainage.

It is derived from glacial material deposited as outwash or in comparatively swift water along stream courses. Where well drained, good yields of corn for fodder are produced. Applications of lime are desirable on some areas of this type.

Hempstead loam.—The soil of the Hempstead loam is friable in structure and brown to black in its range of color. Although a loam in texture, it carries a small amount of white quartz gravel. The subsoil is yellow to reddish yellow and extends to a depth of 24 inches. It is somewhat heavier than the soil. At 24 inches the subsoil lies on a bed of rounded quartz gravel embedded in a sandy loam matrix stained with iron. The topography of the type is level, or practically so, and it is derived from glacial outwash material. The drainage is good on account of the gravel substratum. It is a natural prairie soil occurring east of the Appalachian Mountains. It is utilized under intensive cultivation and fertilization for the production of the medium to late market garden crops.

Hoosic loam.—The surface soil is a light-brown to yellowish-brown loam, about 7 inches in depth, containing a few small, rounded gravel. The subsoil is a yellowish-brown or yellow loam, containing considerably more sand and gravel than the surface soil. The sand and gravel content usually increases with depth, so that the subsoil is a light sandy loam or sandy gravelly loam in texture in the lower part of the profile. The topography varies from level to undulating or slightly rolling and the drainage is good to excessive. The type is easily tilled and is for the most part under cultivation to such crops as corn, small grains, grass, and potatoes. It is also used for fruit, especially peaches.

Hudson loam.—The soil is a light-brown to dark-brown loam or heavy sandy loam, 8 or 10 inches deep, underlain to about 3 feet by a light-colored, compact gravelly sandy loam. Below 3 feet gravelly material is encountered and continues to a considerable depth. The soil has a coarse feel, owing to the presence of some coarse sand and fine gravel. The type is of lacustrine origin. The surface is flat, but the drainage is good. In dry times crops do not suffer from drought. It is an early soil and especially well adapted to potatoes, tomatoes, and root crops, as well as to general farming. Commercial apple orchards have not met with success.

Livingston loam.—The surface soil is a grayish-brown loam, about a foot deep, and is almost identical with the soil of the Dunkirk loam. The subsoil is a heavy silty clay, olive to drab in color. The surface soil is derived from glacial lake deposits foreign to the locality, while the subsoil is derived from the weathering of the underlying soft shales. The soil is poorly drained. When underdrained it is adapted to the production of corn, wheat, oats, grasses, etc.

Mankato loam.—The soil is a heavy, stiff black loam to clay loam, from 1 to 2 feet in depth, resting directly upon bedrock of limestone or sandstone. For a few inches immediately overlying the bedrock the soil is reddish-brown in color and sandy in texture. Groups of gneissic and granitic bowlders varying from 1 to 6 or more feet in diameter occur in places so thick as to render the soil unfit for anything but pasture. The type occupies the position of river ter-

races. It is of residual, alluvial, glacial, and, to a lesser extent, colluvial origin. In wet seasons trouble is experienced in cultivating this soil, necessitating the use of a large part of it for hay or pasture land. On the other hand, in seasons of drought crops suffer badly from lack of moisture. With favorable seasons good crops of corn are grown, though the soil is best adapted to wheat.

Plainfield loam.—The soil of this type is a light-brown medium loam, about 10 inches in depth, underlain by a yellowish-brown or yellowish subsoil of slightly heavier texture, though containing a small proportion of sand and fine gravel. The gravel content increases below 18 inches and frequently grades into a gravel bed. The soil is easy to cultivate and the underlying gravel gives good drainage. In prolonged dry seasons crops are liable to suffer somewhat from lack of water, but in seasons of normal moisture the type is a good general-purpose soil, being particularly well adapted to corn and potatoes. The topography varies from level to somewhat undulating.

Sioux loam.—The surface soil consists of a brown, slightly sandy loam, about 10 inches in depth. It is friable, easily worked, free from stones, and generally quite level. The subsoil has a depth varying between 20 and 40 inches and consists of a brownish-yellow loam, underlain by a reddish gravelly loam, beneath which is a bed of gravel. The type constitutes the higher terraces formed by rivers during the close of the glacial epoch. It is admirably adapted to the production of crops for canning purposes, but is largely used for general farming.

Suffield loam.—The soil is a dark sandy loam 8 inches deep, under which is a layer of rather compact sand, from 12 to 28 inches thick, which rests on heavy, impervious drab clay. The impervious nature of the underlying clay renders the type wet and poorly drained. There is a light formation of iron hardpan in the soil. When properly drained corn, small grains and grass give moderate yields.

Superior loam.—The surface soil is a brown loam, 8 to 14 inches deep, carrying a small percentage of gravel. The subsoil is a heavy loam, usually lighter in color than the soil, and grades into a stiff, pinkish-red clay at from 18 to 24 inches. The type is of lacustrine origin. The surface is gently undulating to moderately rolling, and natural drainage is generally good. The soil is adapted to hay, oats, and wheat.

Tonawanda loam.—The surface soil consists of a brown to black fine, mellow loam, varying from 8 to 16 inches in depth. The subsoil consists of a drab or yellow and brown mottled clay loam or loam to a depth of 24 to 30 inches. This heavy material in turn is underlain by a light-yellow loam or sticky sandy or silty loam to a depth of 3 feet or more. Frequently the last few inches of the section is a sticky sand. Both soil and subsoil are devoid of coarse material. The type is of mixed alluvial and lacustrine origin. The topography is low and flat, with occasional slight elevations along stream courses. The chief crops grown are corn, oats, hay, and potatoes. During favorable seasons fair yields are produced, but crops are practically ruined on an average of one year out of three. On the higher lying portions crops are more certain. The soil is not well adapted to fruit.

Vergennes loam.—The surface soil is a heavy fine sandy loam with an average depth of 10 inches. The subsoil is either a plastic mixture of clay and sand or a medium to heavy loam, which often grades at 3 feet into a stiff clay similar to the subsoil of the Vergennes clay. The subsoil occasionally contains a small percentage of gravel and stones. The type occupies level areas or low, rounded or flat-topped hills and gentle slopes, and is derived from postglacial deposits, modified in some instances by colluvial material or stream action. The soil is desirable for corn and also produces good crops of hay, oats, and barley.

Warners loam.—The soil consists of 10 inches of mellow brown loam, containing many calcareous nodules and a considerable proportion of marl, resting on a subsoil of white or gray marl. The soil is silty in character and has a soft, unctuous feel, containing thin layers of muck at various depths. It produces fairly good crops of corn and grass.

Washburn loam.—The surface soil is a dark-brown or black silty loam, 12 inches deep. The subsoil is a silty loam, mottled grayish-yellow, brown and yellow, and underlain at about 3 feet by yellowish sandy clay. The surface is strewn with granite, gneiss, and sandstone bowlders. Many small shale and slate fragments occur throughout the soil and subsoil. The depth to the underlying limestone is greater than in the case of the Caribou loam. The type occurs as narrow strips along the streams in the depressions which the drainage

waters follow, in small isolated depressions, and as marginal fringes to the Muck areas. Drainage conditions have favored the accumulation of a large quantity of organic matter in the soil. The type is intermediate between the Caribou loam and Muck, and to a certain extent partakes of the characteristics of each. It is especially adapted to grass. Oats and buckwheat do tolerably well. Large yields of potatoes are secured, but the quality is decidedly inferior.

Waukesha loam.—The surface soil is a dark-brown to black, heavy sandy loam to sandy clay, containing some fine gravel. The subsoil is usually light brown, yellow, or yellowish gray in color and the content of gravel increases with depth, the material grading into beds of stratified gravel at 2 or 3 feet. The type occupies gently sloping areas laid down as outwash plains and high terraces of glacial age. This is a very desirable trucking soil and in moist seasons will give good results with small fruits, hay, barley, and corn.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Clyde loam	Indiana 1, 7; Michigan 1, 2, 5, 8; New York 6, 10, 11, 12; North Dakota 2; Wisconsin, 3, 15.	519,852
Fargo loam	Minnesota 3, 4; North Dakota 1, 3, 4, 8, 9	393,984
Dunkirk loam	New York 1, 6, 10, 11, 12, 13, 15; Ohio 3; Pennsylvania 7	245,184
Sioux loam	Illinois 10; Indiana 5, 10; North Dakota 8	73,920
Hempstead loam	New York 7	34,560
Chapman loam	Maine 1	27,648
Vergennes loam	New York 5, 16; Vermont 1	23,936
Suffield loam	Connecticut 1; Massachusetts 1	18,878
Tonawanda loam	New York 12	15,168
Livingston loam	New York 6	13,504
Waukesha loam	Wisconsin 15	13,440
Hoosic loam	New Jersey 2	6,080
Washburn loam	Maine 1	5,504
Chenango loam	New Jersey 2; Pennsylvania 7	4,736
Plainfield loam	Wisconsin 15	4,160
Caneadea loam	New York 6	4,160
Hudson loam	New York 4	3,904
Elmwood loam	Michigan 1	3,810
Bearden loam	North Dakota 8	3,584
Superior loam	Wisconsin 16	3,328
Warners loam	New York 6, 10, 14	2,560
Fox loam	New York 4	1,600
Mankato loam	Minnesota 1	1,600
Total		1,425,100

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

On account of the unusually hilly to rough topography and the presence of large numbers of stones, the greater part of this group is not extensively used for farm crops requiring much cultivation, but is utilized for pasturage. The Dunkirk and Vergennes stony loams are particularly adapted to apples and grapes and to some of the smaller tree fruits, such as peaches, pears, plums, and cherries, while the smoother, less stony areas give good yields of corn, wheat, oats, beans, buckwheat, cabbage, and potatoes. The Lockport and Honeoye types have a rather level to gently undulating topography, but the soils are quite stony and so shallow as to be droughty. They are best suited to grass and pasture, although where the soils are deepest, small grains, potatoes, and apples are grown with fair profit.

Dunkirk stony loam.—The surface soil is a gray or brown sandy loam, containing a large percentage of stone and gravel of different sizes. This overlies a yellowish-brown sandy loam subsoil, generally extending to about 3 feet, which is in turn underlain by gravel and sand at varying depths. The type is derived from glacial material, subjected to subsequent glacial lake action. The topography ranges from nearly level or gently undulating, where the type occurs in the Ontario Lake plains, to quite hilly where it is developed upon small drumlins. Where rolling the natural drainage is good, but level areas require ditching. Where not too steep and stony for cultivation, wheat, oats, corn, and fruits give good yields.

Honeoye stony loam.—This soil consists of a brown loam, from a few inches to about 1 foot in depth, filled with fragments of limestone and resting upon either the massive limestone itself or limestone fragments. It is best suited for pasturage. Where the soil covering is deepest alfalfa thrives.

Lockport stony loam.—The soil varies from a brown to dark reddish-brown loam to heavy loam, about 9 inches in depth, underlain by a reddish-brown or Indian-red clay loam or clay subsoil. Scattered throughout the soil and subsoil are numerous fragments of red Medina sandstone, mixed with a small proportion of glacial gravel and bowlders. The soil is frequently so thin that the subsoil grades into the underlying sandstone at a depth of 3 feet or slightly less. The topography is flat to undulating, and because of this and the heavy character of the subsoil natural drainage is deficient. The native forest vegetation includes elm, scrub oak, hickory, poplar, etc. When cleared and properly drained this type is well suited to the production of corn, oats, wheat, hay, and, on the areas where the soil is deepest, to fruit.

Vergennes stony loam.—The surface soil consists of a clay loam or sometimes of a loam, with an average depth of 8 inches. The subsoil is a gray clay, similar to that of the material of Vergennes clay, but its depth is variable, depending on the position of the underlying rock. The type usually occupies long, narrow ridges or low hills, and also the lower slopes of higher hills. It has been derived from the Champlain clays. Outcrops of limestone occur and large quantities of limestone fragments are found scattered over local areas. Most of the type is left in pasture or woodland. On the more level areas medium yields of corn and hay are secured. The soil is best suited to certain fruits, especially apples, an excellent quality of which is produced.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Dunkirk stony loam	New York 8	38,208
Vergennes stony loam	New York 5, 16, 17; Vermont 1	26,304
Lockport stony loam	New York 10	12,544
Honeoye stony loam	New York 6, 10, 13	9,600
Total		86,656

[1] For key to numbers in this column see p. 733.

STONY GRAVELLY LOAM PHASE.

The stony gravelly loam phase represents a soil which, while relatively smooth, is very leachy, droughty, and of low agricultural value. In wet seasons fair yields of corn, oats, and potatoes can be secured in selected areas which are not so stony at the surface as to preclude cultivation or so porous in the subsoil as to make them droughty.

Chenango stony gravelly loam.—The surface soil is a light-brown or brownish-yellow loam, about 8 inches deep. The subsoil is a light-brown to yellow loam. In both the soil and subsoil small gravel and stones up to the size of cobbles are so numerous as to make boring difficult and to interfere with cultivation. The type occupies high terraces along streams and in the more hilly regions, and also includes more or less small fan deltas where minor lateral streams coalesce with the main valleys. This latter phase, of course, is to a great extent of recent origin. The topography varies from flat to somewhat rolling or hillocky. The drainage is excessive and the soil has a low agricultural value.

Area and distribution of stony gravelly loam.

Soil name.	State or area.[1]	Acres.
Chenango stony gravelly loam	Pennsylvania 4	26,496

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

The soils and subsoils of the gravelly loam phase of this province contain rather higher percentages of interstitial material in the form of silt and clay than are usually present in the gravelly loams of most of the other provinces, and thus form a more efficient reservoir for the storage of moisture for crop uses. Consequently a wider variety of crops can be successfully grown, and the farmer is more independent of moderately dry seasons than in the cultivation of the coarser-textured gravelly loams of other soil provinces. The presence of the moderate amount of small gravel renders the soil friable in structure, early, and easily cultivated. Among the general farm crops excellent yields of corn, both for ensilage and for grain, and of oats, beans, potatoes, clover, timothy, and alfalfa are produced, while the heavier truck crops, like tomatoes, sweet corn, peas, and beans for canning, cabbage, and the root crops, give good yields of fine quality. Fruit does well on selected areas of the Dunkirk, Fishkill, Chenango, and Hoosic types. Hops are quite extensively grown on the Dunkirk gravelly loam in Madison County, N. Y.

Adams gravelly loam.—The soil is a brown, rather light-textured gravelly loam to a depth of about 8 to 10 inches, underlain by a light-brown or yellow gravel or gravelly sandy loam to a depth of 3 feet or more. The content of gravel in the subsoil increases with depth, and usually below 3 feet beds of porous stratified gravel are encountered. The type occurs as delta deposits in former glacial lake Iroquois, at the mouths of streams which brought their detritus principally from areas of crystalline rocks. The topography is usually level. This soil is naturally too droughty for use in general agriculture and is best adapted to the production of special crops, such as early vegetables and some of the fruits.

Caneadea gravelly loam.—The surface soil is a light to dark brown gravelly loam, extending to a depth of 6 to 8 inches. The subsoil to 3 feet is yellowish-brown to ocher-colored gravelly loam. Rounded stones and coarse gravel are abundant in both soil and subsoil. The interstitial material is usually light in texture. The areas of this soil are well drained and quite easily cultivated. It is devoted to general farming, and the yields are usually satisfactory, though often curtailed by drought.

Chenango gravelly loam.—The soil is a brown or reddish loam, 12 inches deep, containing 15 to 30 per cent of rounded gravel, underlain to a depth of 2 feet by a stiff, tenacious clay loam, which is in turn underlain by gravel. The type occupies level or gently rolling river terraces and is composed of original glacial material worked over by the streams. This is recognized as a fine soil for general farm purposes, as well as for fruits for canning.

Dunkirk gravelly loam.—The surface soil varies from a light-brown to brown loam, averaging 10 inches in depth, containing from 20 to 50 per cent of rounded water-worn gravel, principally limestone or shale. The subsoil is a yellowish to brown loam, usually heavier than the soil, with a somewhat higher gravel content, which increases with depth. The type is composed of a reworked glacial deposit occurring as stream and lake terraces. Its position and the porous nature of the subsoil afford thorough drainage. The soil is mellow and easily tilled, the stones seldom being large or numerous enough to offer much resistance to cultivation. Fruits and most of the ordinary farm crops, particularly corn and oats, do well on this soil.

Fargo gravelly loam.—The soil consists of a dark-colored loam or sandy loam, 10 to 12 inches deep, underlain to about 2 or 3 feet by a lighter-colored, coarser-textured material. Scattered upon the surface and disseminated through the soil and subsoil are varying quantities of gravel. Sometimes crystalline rock fragments and shale are also present. At depths ranging from 3 to 10 feet the type is often underlain by beds of gravel and sand. The type is derived from the weathering of glacial-lake beaches. The topography varies from undulating to rolling, and the drainage is inclined to be excessive. The soil is used in places for wheat, oats, and corn. Considerable areas are still in prairie grass.

Fox gravelly loam.—The surface soil consists of a light-brown loam or heavy sandy loam, about 8 inches deep, containing some rounded and some flat shaly gravel. The subsoil is a yellowish, gravelly or heavy sandy loam of about the same texture but containing rather more gravel. The type occupies terraces above the first bottoms along stream courses and owes its origin to glacial outwash and glacial stream-modified material, very often showing cross bedding. This material consists chiefly of shale and sandstone with enough limestone

to give it the character of a calcareous soil. The topography is flat or gently undulating, with occasional kettle holes. The soil is light and friable and easily cultivated, although, on account of its leachy character, crop yields are generally light. It produces corn, potatoes, and some of the truck crops, and in favored locations it is also a fair fruit soil.

Hempstead gravelly loam.—The Hempstead gravelly loam is a brown sandy loam and gravelly loam to a depth of about 8 inches. This is underlain by a yellow gravelly loam usually more silty than the surface soil. The subsoil rests at about 2 feet on gravel and sand. The gravel in both soil and subsoil consists of small quartz pebbles from pea size to a diameter of 2 inches. The topography of the type is essentially level. It is well drained and is derived from glacial outwash material. Market gardening is practically the only agriculture carried on on this soil at present.

Hoosic gravelly loam.—The surface soil is a light-brown to brown gravelly loam, 6 or 8 inches deep, the gravel being usually small, shaly, and waterworn. While some sand is present in the surface, this is more abundant in the subsoil and increases with depth, usually constituting it a gravelly sandy loam. The subsoil is also lighter in color, being a yellowish brown to yellow, though in some areas it has a reddish cast. The topography varies from level to undulating, or somewhat rolling on broken and eroded terraces or where the type is developed as valley kames. Owing to the porous nature of the subsoil, the drainage is good to excessive, the type being usually droughty. Corn, potatoes, and some of the staple truck crops, as well as some fruits, are the commonly grown crops. Both organic matter and lime are required in order to get the best results from this type.

Sioux gravelly loam.—The soil is a dark loam or heavy sandy loam, containing some coarse sand particles, underlain by a yellow stratum of about the same texture and having a depth of 8 to 24 inches. Beneath this occasionally occurs a layer of coarse sand, a few inches thick, which rests on a bed of gravel. The latter is nearly always stratified and varies in extreme cases from a coarse sand on the one hand to the coarsest gravel and bowlders on the other. On low knolls and in other places where erosion has been severe gravel is frequently scattered over the surface of the soil, and occasionally it is turned up by the plow. The type is composed of reworked glacial material. Most of it is level to gently rolling. A large proportion of the type is uncultivated, being used for pasture or hay, which is scant in dry seasons. On the cultivated areas fairly good crops of wheat, barley, flax, etc., are secured in favorable seasons, but practically nothing in dry seasons.

Tunkhannock gravelly loam.—The surface soil is a reddish-brown to brownish-red or Indian-red loam, containing considerable fine waterworn gravel, together with some angular stones, while the subsoil is usually an Indian-red gravelly loam. The type occupies level to undulating or hillocky topography, occurring as both terraces above overflow along streams and as kame deposits in small V-shaped drainageways of high gradient tributary to the main drainage system. It also occasionally occurs as small cone deltas at the mouths of minor lateral streams. The drainage is usually excessive. The crop value is as a rule higher than on the corresponding type of Volusia or Chenango series. The soil is used for general farm crops.

Vergennes gravelly loam.—The surface soil is a sandy loam, from 6 to 10 inches deep, containing from 10 to 45 per cent of fine gravel, pebbles, and small stones. The subsoil consists of light sandy loam or sticky sandy loam, with a gravel content similar to that of the soil. In its lower depths the subsoil often grades into sand with a high content of fine gravel. The type occupies two topographic positions—low bars and ridges surrounded by the Champlain clays of the region, where it represents delta deposits, and broken terrace formations along the ancient shore line. On account of its texture and position this soil is well drained and is susceptible to drought. On the more loamy areas fair yields of corn and hay are secured. The soil is well adapted to the production of potatoes.

Waukesha gravelly loam.—The surface soil is a brownish to black loam, 8 or 10 inches deep, resting upon a subsoil somewhat lighter in color and containing more fine gravel and sand. At a depth of 1½ to 2 feet the gravel increases in quantity, often grading into beds of gravel showing marked stratification. The topography varies from level to undulating or slightly rolling and is best adapted to such crops as rye and oats, although in seasons of considerable rainfall corn gives very fair yields.

Williston gravelly loam.—The soil to an average depth of 12 inches is a brown to dark-brown loam, containing a large quantity of gravel, usually of small size. The content of clay is usually sufficient to give the soil a somewhat sticky character when wet. The surface material is underlain by a somewhat loose and incoherent sandy loam of a lighter color than the soil. The type occurs on sloping to gently rolling terraces, the material having been deposited as glacial stream sediment. When irrigated it should produce good yields of alfalfa and other forage crops, grains, and vegetables.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Dunkirk gravelly loam	New York 1, 6, 9, 10, 11, 13, 14, 15; Ohio 3; Pennsylvania 7	172,800
Chenango gravelly loam	Indiana 5; Michigan 7; New York 2, 3; Ohio 4, 5, 7, 9, 10; Pennsylvania 7.	106,304
Fox gravelly loam	New Jersey 2; New York 4	42,624
Sioux gravelly loam	Minnesota 5; North Dakota 8	32,704
Hoosic gravelly loam	New Jersey 2	26,240
Williston gravelly loam	North Dakota 10	25,536
Hempstead gravelly loam	New York 7	19,264
Caneadea gravelly loam	New York 6, 13	11,328
Vergennes gravelly loam	New York 5, 16; Vermont 1	11,136
Fargo gravelly loam	North Dakota 3, 9	6,528
Tunkhannock gravelly loam	Pennsylvania 4	2,688
Waukesha gravelly loam	Wisconsin 15	704
Adams gravelly loam	New York 5	320
Total		458,176

[1] For key to numbers in this column see p. 733.

SHALE LOAM PHASE.

A relatively large part of the areas of this phase are marked by the presence of large and small shale fragments in sufficient quantities to prohibit the use of the soil for crops requiring much cultivation. Where not too shaly, however, corn, oats, potatoes, and hay are profitably grown. Some tobacco is produced in the Bigflats area, New York, while practically the entire area in Erie County, Pa., is devoted to the production of Concord grapes.

Chenango shale loam.—The soil of the Chenango shale loam ranges from light gray through yellowish to light brown in color and from a loam to a silt loam in texture, and is usually mellow and easily cultivated. The soil carries from 20 to 40 per cent of shale fragments. The subsoil is lighter in color than the soil, being usually yellowish, and varies from about the same texture to lighter where made up mainly of shale fragments. The topography is smooth. The soil occurs in the larger valleys of the northern Allegheny Plateau as alluvial fans spread out where lateral ravines and small stream valleys open onto the broad valleys of the larger streams. The material is mainly shale and sandstone, though fragments of crystalline rock and of limestone may be encountered occasionally. The type is devoted to the production of tobacco and the general farm crops, though good yields are secured only with liberal applications of barnyard manure.

Dunkirk shale loam.—The surface soil is a light-gray loam, 10 or more inches in depth, containing considerable silt and fine sand. The subsoil, from 10 to 24 inches below the surface, is of the same texture as the soil, but lighter in color, and contains large quantities of angular shale fragments or bowlders. All general farm crops are grown, but to obtain the best results a liberal application of manure is required.

Area and distribution of the shale loam.

Soil name.	State or area.[1]	Acres.
Dunkirk shale loam	New York 15; Pennsylvania 7	5,824
Chenango shale loam	New York 2, 3	10,368
Total		16,192

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loam group is the most inextensive of the Glacial Lake province and is adapted to a relatively narrow range of crops. Most of the types are comparatively friable in structure, however, and if cultivated under conditions of optimum water content a mellow seed bed is secured with little difficulty. The soils are for the most part devoted to the production of general farm crops and give excellent yields of corn, wheat, barley, and grass for both hay and pasturage. Timothy and clover both do well, especially the former. The soils are less productive of oats and rye. Tobacco is successfully grown on the Dunkirk silt loam in the Bigflats and Syracuse areas, New York. Besides grain crops the soils give good returns when employed in the production of the heavier truck crops, such as cabbage and many of the root crops, including potatoes, late varieties of which do well in the better-drained locations where the soil is mellow and friable. Apples, peaches, pears, and quinces are successfully grown on suitable ground, especially if within the ameliorating influence of large bodies of water, so that freedom from late frosts is secured. The soil also produces strong nursery stock.

Caneadea silt loam.—The surface soil is a mellow silt or silt loam, pale yellow to gray or dingy white in color, extending to a depth of 10 inches. The subsoil to a depth of 3 feet is a pale-yellow to yellowish-brown or light-drab silt or silt loam. Practically no stones or gravel are found in either soil or subsoil. This soil is easily eroded and if left bare gullies badly. It is adapted to the production of hay, corn for ensilage, etc. It is best suited to dairy farming or animal husbandry in some form.

Chenango silt loam.—The soil to a depth of about 9 inches is a brown silt loam, overlying a silt loam or silty clay loam subsoil of somewhat lighter color. Variable amounts of fine gravel occur in soil and subsoil. The type occurs along streams on terraces lying above overflow and the topography is level to slightly undulating. The soil is easily cultivated and is well adapted to corn, grain, and grass crops, and to pear and apple orchards where suitably located.

Clyde silt loam.—The soil is a dark-gray or chocolate-brown to black silt loam, 10 inches deep, resting upon a similar silt loam of a lemon-yellow color, containing little or no organic matter. The texture is very homogeneous to a depth of 3 feet, and gravel is entirely absent, but there are some bowlders strewn over the surface. The soil is very friable and easily kept in good tilth. It was probably derived from material carried by streams and deposited in glacial lakes. The topography is somewhat rolling and the drainage fairly good. The soil is well adapted to grain and hay and is used for general farm crops and for the production of chicory.

Dunkirk silt loam.—The surface soil to an average depth of 10 inches consists of a pale-yellow to light-brown silt loam. This is underlain by a slightly heavier subsoil of a brown or chocolate color. The type is sedimentary in origin and represents the wash from the higher shale slopes deposited in quiet glacial-lake waters. It occupies lake forelands and the higher terraces along streams. The soil is easily tilled and produces good yields of general farm crops, besides berries, tree fruits, and late truck and canning crops.

Fargo silt loam.—The surface soil is a black to dark-brown silt loam or silty clay loam, with an average depth of about 14 inches. The upper layer of soil contains a large quantity of decomposed organic matter and in some places considerable fine sand. The subsoil is a yellow or grayish silt loam or silty clay. The type is level to gently rolling and is of lacustrine origin. It is a productive soil and is largely under cultivation. It is well adapted to grass and small grain. Wheat, oats, barley, and flax give good yields. Vegetables and garden truck are grown with excellent results. Well-drained areas produce good corn, clover, alfalfa, and sugar beets.

Fox silt loam.—The surface soil consists of a medium brown, fairly loose-textured silt loam 10 inches deep. The subsoil consists of a yellowish-brown loam, and at a depth of from 16 to 24 inches more or less gravel and finely ground limestone rock is found. The type consists of glacial material reworked by streams and deposited in the form of overwash plains. The topography is level or pitted, or slightly rolling, and the natural drainage is very good. With sufficient fertilization the soil is fairly productive of oats, corn, and rye. Some wheat and alfalfa are grown.

Hoosic silt loam.—The surface soil is a silt loam, light brown in color, and extending to a depth of 6 to 12 inches. The subsoil is a pale-brown compact silt loam. The type is derived from quiet-water deposits in high terrace and delta positions. It is well adapted to grass and grain crops, and, where well drained, to corn and potatoes.

Hudson silt loam.—The surface soil varies from a light-brown silt loam to a heavy fine sandy loam, 8 inches deep. The subsoil to 3 feet is a yellowish silt loam, which often becomes drab in the lower depths. The type occupies a terrace above streams and the surface is rolling to flat. The drainage is fair. In the higher locations this soil is well adapted to corn and cabbage, and in the lower, poorer drained locations it is best adapted to hay and pasturage.

Merrimac silt loam.—The surface soil is a brown silty soil, 10 inches deep, containing very little coarse material. The subsoil is a uniform, plastic, yellow silt loam, resting at about 32 inches upon a substratum of coarse sand and gravel. Except for a few glacial erratics, the type is free from stones and gravel. It consists of glacial material reworked by wind or glacial waters. The topography is level to gently undulating and the soil is usually well drained. It is well suited to the ordinary farm crops, and particularly to vegetables and the heavy truck and canning crops, as well as to fruit. The soil is easily kept in good physical condition and responds readily to improved farm methods.

Orono silt loam.—The soil to a depth of 8 or 10 inches is a light-brown, friable silt loam. The upper part of the subsoil is an ashy-gray silt loam, but the texture gradually becomes heavier with depth, passing through a silty clay loam to clay loam or clay. The surface is very gently undulating and drainage is well established. The native tree growth was largely white birch. The type is free of stone and is extensively cleared and cultivated. It is one of the best soils of the locality (central Maine) for general farm crops, including potatoes.

Plainfield silt loam.—The soil is a light-gray to light-brown silt loam, varying from 8 to 12 inches in depth, and underlain by a yellowish-brown heavy silt loam or clay loam subsoil. At from about 18 inches to 3 feet fine gravel is usually found. This underlying gravel provides good subdrainage, so that the soil can be cultivated under a rather wide range of moisture conditions. The topography varies from nearly level to somewhat undulating and the type usually forms outwash plains. It is a good general farm soil and produces moderate yields of ordinary farm crops, including grains, roots, etc.

Poygan silt loam.—The soil is a dark-brown to black silt loam, about 10 inches deep, overlying a pinkish-red heavy silty clay, which is usually calcareous. In some areas the red clay is not encountered nearer to the surface than from 18 to 24 inches, the intervening layer being a light-brown, grayish, or mottled silty clay loam. The topography is level and, on account of the heavy texture of the subsoil, the drainage is poor, so that ditching or tiling is required for the most profitable development of the type. The native timber growth consists principally of elm, ash, cedar, and hemlock. Where cleared and drained this is a strong, productive soil for the staple farm crops, especially for hay.

Sioux silt loam.—The soil is a dark-brown to black, smooth, friable silt loam, 12 inches deep, underlain by a reddish-yellow, heavier silt loam, which in turn is underlain by sand or gravel at from 5 to 8 feet. The type occurs as terraces along streams. The surface soil is gently rolling. The underlying gravel bed affords good underdrainage. This is an exceedingly fertile soil, very highly esteemed for corn and small grain.

Superior silt loam.—The soil is a light chocolate-colored silt loam, from 6 to 10 inches deep, underlain by a silty clay loam, grading into a stiff, red silty clay at varying depths. The type is a lacustrine deposit consisting of reworked glacial material. The surface is usually rough and broken, being often deeply eroded by stream action, and on this account the soil is not of much value for agricultural purposes.

Vergennes silt loam.—The surface soil is a grayish-brown, brownish-gray, or light-drab silt loam, about 9 inches deep. The subsoil is a yellowish-brown, yellowish-gray, or slightly mottled heavy silt loam or silty clay loam. Some fine sand is occasionally present, although at the lower portion of the subsoil the texture is apt to be heavier and overlie a substratum of clay. The surface is rather friable, and if worked under favorable moisture conditions works up into a good tilth. The topography varies from level to undulating and the

drainage is rather deficient. The type is improved by tiling or ditching. The native timber growth is elm, soft maple, pine, and oak. The soil is particularly adapted to the production of hay, corn, ensilage, oats, etc. It is also a good soil for such canning crops as peas.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Dunkirk silt loam	New York 6, 8, 9, 10, 12, 13, 14, 15; Pennsylvania 7	162,944
Fargo silt loam	Minnesota 3, 5; North Dakota 4, 8, 9, 10	154,368
Vergennes silt loam	New York 5	84,288
Plainfield silt loam	Illinois 10; Wisconsin 3, 6, 15	58,048
Clyde silt loam	Michigan 8; New York 13; Wisconsin 3, 4, 8	36,736
Chenango silt loam	New Jersey 2; New York 2, 3; Pennsylvania 4, 7	26,432
Superior silt loam	Minnesota 2; Wisconsin 1	17,664
Fox silt loam	Wisconsin 4, 8	15,040
Caneadea silt loam	New York 6, 13	14,720
Orono silt loam	Maine 2	14,464
Sioux silt loam	Indiana 10; Minnesota 5; Wisconsin 9	9,082
Merrimac silt loam	Rhode Island 1	4,928
Hoosic silt loam	New York 17	4,288
Hudson silt loam	New York 4	1,088
Poygan silt loam	Wisconsin 8	384
Total		604,474

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

By far the largest part of the clay loam group of the Province is included in the Fargo series and confined to the Dakotas and western Minnesota. On account of its high organic matter content, heavy subsoil, and nearness to the level of ground water, the Fargo clay loam is extraordinarily retentive of moisture and constitutes the best wheat soil in this famous wheat-producing section of the United States. Because of the rigorous climate it is a less valuable soil for corn than some of the lighter textured, better drained types, which bring the grain to earlier maturity. Oats, although a subordinate crop, are profitable. Good yields of barley are produced, as well as some hemp, while the type is probably unsurpassed in the production of timothy, clover, and other grasses for hay. Next to the Fargo the Dunkirk and Clyde types have the largest extent, and are especially important in the production of grains and grasses. These are all excellent dairying types and, together with the less important series, are among the most valuable soils for heavy truck and canning crops. In favorable topographic situations and with suitable climate the Dunkirk, Hudson, and some of the other types are well adapted to fruit, especially apples and pears, while small fruits and bush berries are grown with fair success. Nearly all of this group of soils are level to only gently rolling in topography, so that artificial drainage is a necessary factor in their reclamation and improvement.

Clyde clay loam.—The surface soil is a dark-brown or black loam, from 8 to 14 inches deep, resting upon a yellow or drab-colored clay, often streaked with iron stains. The clay subsoil is a plastic, somewhat silty material when wet, and contains very little coarse sand or fine gravel, excepting along stream courses, where coarse material may be encountered within the 3-foot section. The type is lacustrine in origin, combined with some reworked glacial till. It occupies level areas, and the drainage is poor. Comparatively few areas are under cultivation. Corn, oats, and hay are the principal general farm crops grown. Cabbage, onions, and celery are quite extensively grown on some parts of the type. Nearly all of the type is capable of improvement through drainage, and when reclaimed will prove to be a very good soil for both general farming and trucking.

Dunkirk clay loam.—The surface soil is a dark-brown to grayish-brown clay loam, 8 inches in depth. It is quite stiff and heavy and cracks upon drying. The subsoil is a mottled brown and gray heavy clay loam or clay. Both soil and subsoil are generally free from stones or gravel, although small quantities are sometimes found in local spots. The type is derived from lacustrine sediments laid down in glacial lakes, though mixed to a greater or less extent with glacial till material and possibly some residual material from the local

underlying rocks. It occupies gently undulating areas and the slopes of hills, which are sometimes quite abrupt. The drainage is adequate in some locations, but in the nearly level or depressed areas it is often necessary to resort to artificial drainage. On account of its heavy, compact nature the subsoil is almost impervious to water. The soil is well adapted to wheat, and grass and corn also do fairly well. Alfalfa has been successfully grown in some localities. It is well adapted to grapes.

Fargo clay loam.—The surface soil consists of 1 to 2 feet of a dark-brown to black clay loam to silty clay, often containing a large percentage of organic material. From 4 to 8 inches of the surface material is often mucky in the deeper depressions. The subsoil is a heavy drab to gray, grayish-brown, or bluish-black silty clay to clay, often having a finely stratified structure. The type has the general appearance of being almost level, but gentle swells and shallow depressions give to it a very gently rolling topography, consequently it is poorly drained. The materials of which the type is composed probably owe their origin to deposits laid down in the beds of old lakes and shallow ponds of glacial age and also to further alluvial deposits laid down in more recent times. Large areas are too wet for agricultural purposes, but when thoroughly drained cultivation is possible. The relatively large quantity of organic matter in the soil renders it loamy, friable, and easily cultivated when drained, but when wet it is sticky and tenacious, clods badly, and does not scour well, making plowing almost impossible. When well drained this type is a valuable soil for general farming purposes. The principal crops grown are corn, wheat, oats, flax, and millet. Barley, timothy, and hemp are grown to some extent. The soil is not particularly adapted to rye, potatoes, or vegetables.

Hudson clay loam.—The soil is a light-brown or drab silty clay loam, 6 or 7 inches deep, underlain by a plastic silty clay, which in the lower depths grades into a stiff, tenacious silty clay of mottled drab, blue, and yellow color. The type is of lacustrine origin. It is used extensively for brick making. The surface is usually flat and poorly drained, but in places its original terrace form has been deeply eroded. This is considered a cold, wet soil, and when dry the surface bakes and cracks, and crops suffer from drought. Cedars thrive. The soil is not well adapted to general farming, but is especially good for grass. Its texture is greatly improved by the application of lime and coarse manures.

Poygan clay loam.—This type consists of a dark-brown to black heavy loam or clay loam, 10 inches deep, underlain to a depth of 3 feet by a heavy pinkish-red clay. It is an easily tilled soil, owing to its large content of organic matter. The type is derived from the weathering of lacustrine sediments deposited at a time when the Great Lakes stood at a higher level than at present. It produces good yields of corn, oats, potatoes, and hay, and is an excellent dairying type. It occupies low, level to slightly undulating areas, and the depth to ground water is usually only a few feet.

Sioux clay loam.—The surface soil consists of a brown, mellow clay loam, from 8 to 14 inches deep. The subsoil is a yellow clay loam or clay, which usually becomes heavier below 2 feet. Throughout the soil and subsoil a small quantity of rounded gravel is disseminated. The type is underlain usually by sandy or gravelly material, and on this account the greater proportion of it has excellent drainage. Seepage waters from adjacent slopes or higher lands give rise to local conditions of poor drainage. The type occupies nearly level terraces built up by glacial flood waters. It is used largely for corn, wheat, and grass. Truck crops, such as cabbage and tomatoes, give moderate yields, and berries and potatoes do well.

Superior clay loam.—This is a light-brown or reddish loam, grading into a pinkish-red or light chocolate red silty clay at about 8 inches. The type is derived from the weathering of lacustrine sediments deposited during glacial lake occupancy of the country. The topography is level to gently sloping, and the water table is usually only a few feet below the surface. Artificial drainage is usually necessary. The soil is very retentive of moisture, and when adequate drainage is established good yields of corn, oats, and hay are produced.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Fargo clay loam	Minnesota 1, 3, 5; North Dakota 3, 9; South Dakota 2	601,024
Dunkirk clay loam	Michigan 10; New York 1, 9, 12, 15; Ohio 8	128,768
Poygan clay loam	Wisconsin 16	23,232
Clyde clay loam	Michigan 10; New York 11; Wisconsin 12	16,960
Superior clay loam	Wisconsin 7, 8, 16	12,032
Hudson clay loam	New York 4	9,984
Sioux clay loam	Indiana 4	2,240
Total		794,240

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loam phase is of relatively small extent, but is typically developed in the Great Lakes region. It contains more silt and less of the various grades of sand than do the clay loams, giving it a heavier texture. It is more difficult to work, and greater care is necessary to prevent the formation of clods. Under the most intelligent methods of cultivation, however, the soils are very productive of the small grains, especially wheat, and are excellent hay lands. In favorable locations apples, pears, quinces, and nursery stock are grown with good results. The type is probably best adapted to wheat and grass.

Clyde silty clay loam.—This is a dark-brown to black silty clay loam, ranging from 6 to 10 inches in depth, and underlain by a drab or gray usually mottled clay subsoil. The topography is level and the drainage is naturally poor, so that ditching is necessary before crops can be profitably grown. When reclaimed through drainage the type is strong and productive and good yields of corn and general farm crops are secured. Such crops as cabbage and onions are also very well adapted to it. Timothy and redtop produce from 1 to 2½ tons per acre on reclaimed land.

Dunkirk silty clay loam.—The soil is a brown, light-brown, or grayish-brown, heavy, silty clay loam, 6 or 8 inches in depth, underlain by a brown or sometimes chocolate-colored heavy clay subsoil. Although a small quantity of stone and gravel are sometimes found in the type, this is not a noticeable characteristic. The type is derived from the wash from glacial material deposited in various ways as till, moraine, etc., and subsequently modified by glacial lakes, the material being reworked and redeposited under quiet-water conditions. The topography is level to slightly rolling, and while the surface drainage is fair, on account of the dense, impervious character of the subsoil, the internal drainage is poor, so that open ditches or tile drains are necessary for the best improvement of the land. The soil is very well adapted to corn and grass, and yields of wheat range from 15 to 30 bushels; oats, 40 to 50 bushels; and hay, 1½ to 2 tons per acre. Buckwheat is grown to some extent.

Livingston silty clay loam.—The soil is a brown to light-brown heavy loam or silty clay loam, about 10 inches deep, overlying a dense silty clay loam or clay of mottled gray color. The topography is nearly level to gently undulating and the natural drainage is inadequate, both on account of the unfavorable surface topography and the dense, impervious nature of the subsoil. The principal native forest growth consists of oaks and hickory, with some elm. When well drained, the areas are adapted to corn, wheat, beans, etc., and to hay.

Superior silty clay loam.—The surface soil is reddish-brown in color to a depth of 8 inches. The subsoil is red. The texture of the soil is a silty clay loam, that of the subsoil is a clay, which, when exposed, cracks badly in dry weather. Small fragments of stone, often limestone, occur throughout the soil and subsoil, though large bowlders are of rather rare occurrence in the soil. This type is glacial in origin, being laid down by the melting of the ice sheet, but the red clay is supposed to have been lacustrine clay before being taken up by the ice. The topography is level to undulating or gently rolling. The soil is adapted to general farming.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Clyde silty clay loam	Wisconsin 4, 15	68,928
Dunkirk silty clay loam	New York 10, 13	55,232
Superior silty clay loam	Wisconsin 4	8,064
Livingston silt clay loam	New York 13	6,208
Total		138,432

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The clay group comprises the second largest group in the province and is very important in connection with dairying and the production of hay for market. The soils are very heavy in texture, making them difficult to till, so that considerable labor and heavy teams and improved implements are necessary when they are utilized for the ordinary intertilled crops. In the production of hay the minimum of tillage is required, and on smooth stone-free ground improved hay-harvesting machinery is employed, so that little hand labor is necessary. Timothy and clover both do well on most of these soils, though on some of them alsike and white clover are slightly better suited to the heavy textured subsoils, on account of the peculiarity of their root development. Redtop does well on some of the soils, which are rather too poorly drained for timothy and clover, while alfalfa has proved successful on some of the better drained, more pervious soils. The clays are also excellent producers of wheat, although in some regions where winter wheat is grown some difficulty is encountered, owing to the tendency of the crop to heave out of the ground during the cold season. Good yields of oats are produced on well-drained, rolling areas, though they are usually as fully productive and more easily handled on lighter soils. Corn is successfully grown only upon the lighter-textured phases, where drainage is of the best and where the presence of considerable organic matter renders the soils unusually friable. The Clyde and Fargo types are thus better suited to corn, in favorable latitudes, than the Dunkirk, which contains considerably less organic matter. The soils are too heavy for the successful growing of potatoes, for, although yields are sometimes very heavy, the tubers are badly shaped and often watery and hollow. Other root crops, such as sugar beets, mangel-wurzels for stock food, turnips, and carrots, are fairly well suited to these clay soils. Good yields of a fine quality of cabbage for winter storage are secured. Some onions and celery are occasionally grown on such types as the Clyde and Fargo in locations where the soil is slightly mucky, owing to the content of organic matter. The growing of bush fruits has been fairly successful on some of the inland types, but the drainage of the subsoils is too sluggish for success with apples and most of the tree fruits. Pears, however, should do well in carefully selected locations. It is in the production of hay, however, that the soils of the clay group excel, and, so far as this crop can be economically produced for the market, the soils should be utilized for its production.

Caneadea clay.—The surface soil is a gray to drab heavy silty clay, about 6 inches deep. The subsoil is a dense clay, drab to brown in color. The underlying shale or sandstone is sometimes reached in the third foot. This type is tough and plastic in character and very difficult to cultivate. It is of lacustrine origin. The topography is rolling and the surface drainage is good, but underdrainage is desirable. The soil is best adapted to the production of hay and to permanent pasture.

Clyde clay.—The surface soil is a rather silty clay of a brown or black color, and from 6 to 9 inches deep. Where the proportion of organic matter is highest the soil is darkest and more loamy and friable. The subsoil is a bluish or drab-colored clay, very tenacious and practically impervious to water. The type is derived from glacial lake deposits and occupies low wet, level areas, some of which were originally covered with peat. With good drainage the soil is well adapted to sugar beets, as well as to general farm crops, especially grass. It is a good dairy type.

Dunkirk clay.—The soil is a drab or gray clay, 6 to 12 inches in depth, underlain by a tenacious, mottled gray, brown and yellow clay, beneath which, at a depth of 4 to 10 feet, occurs the typical bowlder clay. Near ancient beach lines the soil is sometimes underlain by gravel. The type is found upon lake forelands and in upland valleys and is derived from deposition in quiet water. Some areas are poorly drained. The soil is adapted to grapes, grain, and grass, as well as to wheat and hay.

Fargo clay.—The soil is a heavy black clay, 6 to 14 inches deep, underlain by gray or blue clay of the same texture. At from 5 to 9 feet occurs a mottled gray, brown, and yellow clay, similar to the subsoil of the Miami black clay loam. When wet this type is very waxy and gummy and has an oily feel. It is exceedingly slippery under foot and often sticks to wagon wheels in great quantities. The type occurs in depressions in the upland. The drainage is poor and the soil is difficult to till. It is a very strong and productive soil when well drained, and is adapted to general farm crops, especially wheat, oats, barley, and corn.

Lockport clay.—This type is a heavy red to brown clay loam, from 4 to 8 inches deep, underlain by a stiff Indian-red clay. Under most of the type bedrock occurs at a depth greater than 3 feet, but occasionally it is encountered within the third foot. The soil is largely residual, being the weathered product of red Medina shale mixed with some glacial material near the surface. The type is marked by nearly level areas, the surface of which is thickly strewn with large granitic bowlders. Owing to its level, stony nature, the greater part of the type is devoted to pasture and woodlots. It is best suited to grass, which fact has been generally recognized. Tree fruits of all kinds are generally a failure. Bush fruits do better.

Poygan clay.—The soil is a dark-brown to black heavy loam, about 10 inches deep, underlain by a pinkish-red clay, which in some instances is mottled with white. This is sometimes succeeded by a stratum of water-saturated sand. The surface contains considerable organic matter, and tillage is not especially difficult. This type is derived from the weathering of lacustrine sediments deposited at a time when the Great Lakes stood at a higher level than at present. The soil occupies level areas in old lake bottoms and always requires artificial drainage. It is well adapted to grass and produces good yields of corn and oats.

Sioux clay.—The Sioux clay is a black, dark-brown, or sometimes yellowish-brown clay loam or clay, about 18 inches deep, underlain by a grayish-brown or grayish-yellow clay of stiff, tenacious, waxy texture. The type occupies river bottoms, and is partly alluvial and partly a wash from the uplands, the latter areas having the characteristics of the gumbo found in the Red River Valley. It is an excellent soil for small grain, wheat sometimes yielding as much as 40 bushels per acre. Oats and flax also do remarkably well. The lighter areas are suitable for certain of the truck crops. The native vegetation consists of oak, elm, ash, and other forest trees.

Suffield clay.—The soil is a clay loam, 12 inches deep, underlain by a close-textured, laminated clay subsoil. The type owes its origin to lacustrine deposits. It occupies very poorly drained, level areas in the Connecticut Valley. On account of its poorly drained condition and close structure, the soil is not adapted at present to any agricultural purposes, although used to some extent for pasturage.

Superior clay.—This is a heavy, compact, and almost impervious pinkish red clay, with no apparent difference in color or texture between soil and subsoil. When wet it is of a bright brick-red color and quite adhesive and gummy; when dry cracks an inch or more in width are common on the surface, and the soil breaks up into cubical blocks. Sometimes there are small fragments of rock in both soil and subsoil, and usually upon new ground there is an inch or so of vegetable mold. This type is lacustrine in origin. It occurs generally in broad, flat areas, with surface inclinations toward streams, and is very retentive of moisture. The soil is adapted to timothy and clover. It improves with use, and good crops of potatoes, peas, beets, and other root crops have been grown.

Vergennes clay.—The surface soil consists of heavy gray clay or light-brown clay loam, varying in depth from 6 to 12 inches. The subsoil is a gray, drab, or light-brown heavy clay, somewhat tenacious when wet, but extremely stiff, compact, and intractable when dry. Wherever the soil is so shallow that the plow goes below it the upturned furrows of the underlying gray clay become white upon exposure to the atmosphere, and this has given rise to the local term "white-faced clay." On the steep slopes of many ridges outcrops of slate are

frequent, and thin fragments are often strewn over the tops and the steeper slopes. This type is derived from the postglacial or Champlain clays. The glacial material comes to the surface, or nearest it, on the hills, and in some cases this has been washed down the slopes and mingled with the post-glacial clays. The type for the most part is level to gently rolling, broken only by occasional ridges. Except in the depressions, it has sufficient surface drainage. As the greater part of this soil is compact and impervious to moisture, underdrainage would result in better crop returns. This is an excellent soil for hay. Other crops giving profitable yields are corn, oats, and barley.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Vergennes clay	New York 5, 16, 17; Vermont 1	430,912
Clyde clay	Indiana 1, 3; Michigan 8, 9; New York 5, 12; North Dakota 1; Ohio 8.	319,040
Superior clay	Michigan 4; Minnesota 2, 6; Wisconsin 1, 2, 13	311,360
Dunkirk clay	New York 1, 6, 8, 9, 11, 12, 13, 14, 18; Ohio 1, 3; Pennsylvania 7	212,290
Fargo clay	Minnesota 1; North Dakota 3, 8, 9, 11	159,296
Poygan clay	Wisconsin 4, 16	37,696
Suffield clay	Connecticut 1; Massachusetts 1	23,610
Lockport clay	New York 12	6,656
Sioux clay	North Dakota 5	2,432
Caneadea clay	New York 6	1,280
Total		1,504,572

[1] For key to numbers in this column see p. 733.

BLACK CLAY PHASE.

But one type of the black clay phase has so far been recognized, and it is not unlikely that further study will show this to be in all essential respects similar to the Clyde clay or some of the other black clays mapped farther west in the Great Lakes region. An abundance of organic matter gives the soil a friable structure for one of so heavy a texture, so that the labor of cultivating it for intertilled crops is attended with less difficulty than in the case of some of the other clays.

Vergennes black clay.—The surface soil consists of a black loamy clay, from 6 to 15 inches deep. It contains a high percentage of organic matter and is very tenacious and sticky when wet, but is granular and friable when dry. The subsoil is a heavy, tenacious drab clay, somewhat plastic in certain areas. The soil is more often underlain at 24 inches by a stiff heavy clay, similar to the subsoil of the Vergennes clay. The type owes its origin chiefly to wash from higher lands mingled with decaying vegetation, thus giving rise to a rich black soil. The surface is usually flat or basinlike, and artificial drainage is often necessary to secure the best yields. It is naturally a strong and productive soil and gives large yields of corn and hay.

Area and distribution of the black clay.

Soil name.	State or area.[1]	Acres.
Vergennes black clay	New York 17; Vermont 1	4,224

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

In the restricted development of the stony clay phase the presence of the stone and gravel in the subsoil has the effect of securing better internal drainage than would otherwise be the case. This beneficial influence, in conjunction with a more rolling topography than usually attends the clay soils of the Glacial Lake province, permits the profitable growing of fruit, including apples, pears, and grapes.

Dunkirk stony clay.—The surface soil is a compact yellow silty clay loam, 8 inches deep, containing from 10 to 20 per cent of small, rounded or angular stones. The subsoil is a brown, yellowish-brown, or mottled stiff clay, which becomes very sticky and plastic when wet. The stone content of the subsoil is greater than that of the soil. The type is probably derived from an old lake sediment. It occurs in steeply to gently sloping areas, characterized by a series of parallel ridges and gullies. At the maximum elevation the surface is rather flat and the soil deeper; although there is usually sufficient surface drainage, the underdrainage is retarded by the very compact nature of the subsoil, so that ditching and tiling are necessary. The soil is well adapted to grapes, producing about 4 tons to the acre, and pears and apples also do well. Wheat and grass are profitably grown, the former averaging 20 or more bushels to the acre and the latter from 1½ to 3 tons of hay.

Area and distribution of the stony clay.

Soil name.	State or area.[1]	Acres.
Dunkirk stony clay	New York 1, 6, 15	40,064

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

The presence of a rather large proportion of silt in this soil is beneficial in ameliorating the otherwise dense character of a clay soil, so that tillage operations are carried on with less difficulty and the soil can be worked under a wider range of moisture conditions. Judiciously selected areas of this type can be utilized for the production of late potatoes to some extent, as is the case with the Superior clay, which also possesses more than ordinary quantities of silt. Where lighter types of soil can be secured for the growing of root crops, however, this type should be left for the production of grass and the small grains.

Orono silty clay.—The soil is an ashy-gray silty clay, underlain by the same material several feet deep. When dry it is darker colored, often a dark bluish-gray, and becomes more sticky and plastic. It is free from stones and gravel. This type is derived from stratified drift and occupies an almost continuous estuarine and glacial-lake plain below the 230-foot contour. The surface is level or very gently undulating, and both surface and subdrainage are insufficient. The native growth was white birch and alder, but a large proportion of the type is cleared and under cultivation. It is an excellent grass and grain soil and is extensively used for general farm crops, including potatoes, but must be artificially underdrained to insure their success. Very little, if any, underdrainage has been attempted.

Area and distribution of the silty clay.

Soil name.	State or area.[1]	Acres.
Orono silty clay	Maine 2	83,200

[1] For key to number in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the soils of the miscellaneous materials.

Soil name.	State or area.[1]	Acres.
Muck	Illinois 11; Indiana 4, 5, 6, 10; Iowa 1; Maine 1; Michigan 1, 2, 3, 4, 5, 6, 7, 8, 10; Minnesota 2; New Jersey 2; New York, 1, 3, 5, 6, 8, 9, 10, 12, 13, 14, 17; North Dakota 4; Ohio 3; Vermont 1; Wisconsin 6, 11, 12, 13, 16.	656,426
Peat	Illinois 10; Indiana 1, 3, 7; Minnesota 1, 3; New York 2; Ohio 10; Wisconsin 4, 10.	120,320
Dunesand	Michigan 1, 4; Minnesota 6; New York 5, 10; North Dakota 8, 10; Rhode Island 1; Wisconsin 13.	56,506
Swamp	Indiana 7; Michigan 7, 8; New York 3, 14, 16; Rhode Island 1; Vermont 1.	48,256
Marsh	Michigan 4; New York 5, 10, 17; Wisconsin 1	13,888
Coastal beach, beach gravel, and beach sand.	New York 5; Rhode Island 1; Wisconsin 1	4,864
Tidal marsh	Rhode Island 1	4,224
Total		904,484

[1] For key to numbers in this column see p. 733.

Revision of September, 1912.

Key to the Soils of the Glacial Lake and River Terrace Province.

- Drainage well established
  - Black soil
    - Light brown subsoil
      - Lidgerwood
      - Substratum gravel and coarse sand
        - Generally calcareous
          - Sioux
    - Yellow subsoil
      - Waukesha
    - Reddish brown subsoil
      - Substratum limestone and sandstone
        - Mankato
    - White subsoil
      - Calcareous
        - Williston
  - Brown soil
    - No subsoil
      - Substratum limestone
        - Honeoye
  - Red soil
    - Red subsoil
      - Sandstone and shale material
        - Wash from red till uplands soils
          - High terraces
            - Tunkhennock
  - Gray to brown soil
    - Yellow subsoil
      - Sandstone shale and limestone material
        - Dunkirk
        - Substratum sand and gravel
          - Chenango
      - Shale and sandstone material mixed
        - Friable subsoil
          - Caneadea
      - Schistose and slaty rock material
        - Hoosic
      - Mainly limestone material
        - Fox
      - Sandstone and mixed glacial material
        - Subsoil porous and noncalcareous
          - Plainfield
      - Slate and some limestone material
        - Hudson
      - Granite, sandstone and shale material
        - Subsoil porous and noncalcareous
          - Adams
      - Diabase and fine-grained crystalline and triassic sandstone material
        - Hartford
        - Substratum red triassic sandstone
          - Manchester
      - Coarse grained granitic till material
        - Merrimac
  - Dark gray soil
    - Gray subsoil
      - Mixed glacial material
        - Calcareous
          - Substratum quick sand
            - Bearden
- Drainage poorly established
  - Black soil
    - Mottled drab and yellow subsoil
      - Clyde
      - Calcareous
        - Subsoil stiff and plastic
          - Fargo
        - Subsoil silty and moderately friable
          - Fragments of stone conspicuous
            - Washburn
        - Subsoil sandy and very friable
          - Substratum gravel
            - Benoit
      - Subsoil friable
        - Substratum very friable yellow loam
          - Tonowanda
      - Diabase and fine grained crystalline and triassic sandstone material
        - Stiff impervious subsoil
          - Suffield
    - Pinkish red clay subsoil
      - Poygan
  - Yellow soil
    - Drab subsoil
      - Impervious clay
        - Elmwood
    - Black subsoil
      - Substratum sand and peat
        - Newton
    - Light gray subsoil till material
      - Hummocky surface
        - Chapman
  - Gray to brown soil
    - Gray subsoil
      - Substratum mottled olive and yellow from soft shale
        - Livingston
    - Drab subsoil
      - Iron hardpan
        - Saugatuck
      - Very stiff and tenacious
        - Vergennes
    - Yellow subsoil
      - Mixed Fargo and dune-sand material
        - Walcott
      - Mottled
        - Granitic material
          - Orono
      - Impervious
        - Tuscarora
    - No subsoil
      - Substratum white marl
        - Warner
  - Red to reddish soil
    - Pinkish red silty clay subsoil
      - Superior
    - Indian red subsoil
      - Substratum red shale
        - Lockport

SOILS OF THE ATLANTIC AND GULF COASTAL PLAINS PROVINCE.

By Hugh H. Bennett.

DESCRIPTION OF THE PROVINCE.

BOUNDARIES.

The Atlantic and Gulf Coastal Plains constitute one of the most important physiographic divisions of the United States. This province comprises approximately 365,000 square miles of the predominantly flat to smoothly rolling region bordering the Atlantic Ocean and extending from the northern end of Long Island in New York to the southern extremity of the Florida Peninsula and along the Gulf of Mexico to the mouth of the Rio Grande. From a narrow strip along the coast of Long Island the Atlantic division of this great province widens southward to a width of 200 miles in North Carolina, becoming slightly narrower to the south, and again approximating a width of 200 miles at Fernandina, Fla. The distance between the coast at Pensacola, Fla., and the inland border of the Gulf division of the Coastal Plain is close to 200 miles. From this point the province broadens rapidly toward the Mississippi River, until the maximum width for the entire Coastal Plain province is reached along the meridian from the Gulf coast near the Alabama-Mississippi line to a point near the Kentucky line in the neighborhood of Paris, Tenn., a distance of nearly 450 miles. The distance to the northern inland boundary from Galveston, Tex., is approximately 350 miles and to the western boundary about 225 miles.

Between New York City and Clanton, Ala., the inner boundary of the Coastal Plain is marked by the border of the Piedmont Plateau. This boundary line passes approximately through New Brunswick, N. J.; Chester, Pa.; Wilmington, Del.; Baltimore; Washington; Richmond; Petersburg; Raleigh; Columbia; Augusta; and Columbus, Ga. From the vicinity of Clanton, Ala., the line runs in a northwesterly direction along the southern border of the Appalachian Mountain system to the northeast corner of Mississippi, and thence in a northerly direction to the Kentucky border near Paris, Tenn.

There is a broad gap in the Gulf Plain represented by the Mississippi bottoms and the belt of loessial soils adjoining the bottoms on the east and extending from Kentucky to the vincinity of Lake Pontchartrain, La. Thus the western border of the Gulf Plain east of the Mississippi River is approximately marked by a line extending northeasterly from the neighborhood of Hammond, La., through Jackson, Miss., to the vicinity of Paris, Tenn.

West of the Mississippi the Gulf Plain is encountered near Little Rock, Ark., from which point the inland boundary skirts the Ozark border, embracing a narrow strip of southern Oklahoma as far west as Ardmore, and extends southwestward to Brownwood, Tex., thence westerly to San Angelo, and southward to the Mexican border near Boquillas, Mexico.

The Atlantic and Gulf Coastal Plains province includes roughly the seaward margin of Long Island, N. Y., the southern two-thirds of New Jersey, nearly all of Delaware, the eastern and southern two-thirds of Maryland, the eastern third of Virginia, the corresponding part of North Carolina, the eastern half of South Carolina, the southeastern half of Georgia, all of Florida, the southern and western two-thirds of Alabama, practically all of the eastern half of Mississippi, a narrow strip in western Tennessee, the southern one-third of Arkansas, a narrow strip of southeastern Oklahoma, the western two-thirds of Louisiana, and the eastern and southern two-fifths of Texas.

PHYSIOGRAPHY.

In its general aspect the Atlantic and Gulf Coastal Plains province consists of a broad plain which rises gradually either from sea level or low bluffs along the coast to the border of the higher inland regions of different topographic forms, namely, (1) the Piedmont Plateau, representing the inner border of the

Atlantic Coastal Plain; (2) the Limestone Valleys and Uplands; (3) the Appalachian Mountains and Plateaus, marking the inland boundary of the eastern Gulf division; (4) the Ozark and Arbuckle Mountains; and (5) the Residual Prairie region, defining the interior limits of the western Gulf division. The inner boundary, representing the highest part of the main province, varies from about 200 to 500 or 600 feet above sea level. This region, although formerly a plain having a gradual slope from the sea inland, has been eroded since its uplift above sea level to its present varying topographic features of low to moderate relief as compared with the much more uneven surface of the Appalachian and Piedmont regions. There are, here and there, some prominent elevations between the coast and the inner border, and local areas have been so severely eroded that their surface is too uneven for profitable tillage.

Several well-defined subordinate topographic features are included in the Coastal Plains province. The lowest and smoothest division is embraced in the Flatwoods region of the Atlantic and eastern Gulf coast and its prairie equivalent, the flat Coastal Prairies of Louisiana and Texas.

FLATWOODS AND COASTAL PRAIRIES.

The Atlantic Flatwoods region assumes importance as a physiographic feature in southeastern Delaware, extends southward as a narrow fringe along the Maryland coast, includes the southern end of the Maryland-Virginia peninsula and the country lying to the east of a line passing approximately through Yorktown and Suffolk, Va., crosses North Carolina, South Carolina, and Georgia at a distance varying from 20 to 40 miles from the coast, and extends across Florida, through Live Oak, to the vicinity of Appalachee Bay. This includes a portion of the interior Florida Peninsula which does not have the characteristic flatness of the typical Flatwoods region, but comprises a section of hillocky and low, ridgy topography.

Beginning as a narrow fringe at Moble, Ala., and widening westward to nearly 30 miles in central Mississippi is another strip of Flatwoods which is dominantly of the same topography as the Atlantic Flatwoods. This belt merges into the Mississippi alluvium and the loessial soil regions between Pearl River and Lake Pontchartrain.

The Flatwoods belt typically has the appearance of a dead-level plain, varied occasionally by slight sand hillocks and ridges and shallow valleys of the streams rising within the region. The average inland slope is close to 2 feet to the mile, although many broad areas have a gradient of less than 1 foot. The elevation of the inland border ranges roughly from 15 to 30 feet between Delaware and the southern Virginia line, 40 to 50 feet in North Carolina, 50 to 100 feet in South Carolina, and 100 to 125 feet in Georgia and Florida. Between the coast and inner border of the Gulf Flatwoods there is a rise of approximately 50 to 75 feet.

The coast line of most of this region is marked by long narrow sand bars and barrier islands, fronted on the ocean side with a narrow ridge of dune sand from 15 to 50 feet high. Coral keys take the place of the sand bars and islands about the southern coast of the Florida Peninsula. Generally the mainland, which is separated from the bars and islands by sounds and tidal marshes, rises from the edge of the water or tidal marshes in a distinct bluff scarp seldom more than 10 to 15 feet in height. There are places, however, where the mainland slopes imperceptibly off to the water or the tidal marsh. The inland boundary of the region is marked both by sudden and gradual rises to the older and more rolling inner Coastal Plain.

On account of the flat surface the drainage over the greater part of the Flatwoods is poor. With the exception of the larger streams crossing the region, such as the James, Roanoke, Pee Dee, Santee, Savannah, and Altamaha Rivers, most of the drainage finds its way through slight depressions and swampy streams in which there is usually no well-defined channel and but a sluggish current. In many sections shallow drainageways are numerous, winding in and out and often rejoining each other to form an interminable network of waterways. Elsewhere there are broad stretches with but few drainage outlets from which the rain water flows off and seeps down so slowly that the water table is permanently maintained near the surface. Some of these flat stretches which support only a sparse growth of trees are locally called "savannas" and "prairies." Over some of the flat areas having few outlets for the removal of rain water the drainage is so poor that a dense growth of water-loving plants and trees has become established. These "bays,"

"pocosins," and "swamps" constitute what might properly be considered upland swamps.

The western Gulf equivalent of the Flatwoods, generally known as the Coastal Prairie, comprises a coastal strip from 25 to 100 miles wide, beginning in central Louisiana and continuing to the Mexican border. This strip is mainly treeless and its surface is so flat that in many places a broad view does not show any perceptible variation of surface contour. Although presenting little topographic diversity throughout its main extent, local areas are slightly dissected by streams or "arroyos" or are billowy as a result of drifting sand. As in the Flatwoods region, this belt is dissected by conspicuous, broad-bottomed valleys of the larger streams, such as the Colorado, Brazos, Trinity, and Rio Grande. The inland boundary is approximately marked by the 100-foot contour line. The regional drainage, even in the humid portion of the section, outside of the Coastal marsh areas, is better established than in the Flatwoods region of the Atlantic coast.

INNER COASTAL PLAIN.

The higher part of the Atlantic and Gulf Coastal Plains, the interior division of the province, covers a much larger area and is far more varied in its surface configuration than the adjacent Flatwoods and Coastal Prairies. Topographically this inner division varies from flat to hilly, and its elevation for the greater part ranges from about 20 to 100 feet along the outer margin to 500 or 600 feet along the inner border. The region is prevailingly one of moderate relief, except along the inner margin, where the land is generally deeply dissected, owing to long-continued erosion and the higher elevation. There are, however, irregularly distributed groups of hills and ridges that rise to conspicuous elevations, occasionally to 500 feet, or even to 1,000 feet in southwestern Texas. With these occasional exceptions, including the steep valley slopes of the major streams which have cut deep trenches through the dominantly soft material of the region, the surface features are well suited to tillage operations.

North of the Virginia-North Carolina line the greater part of the Coastal Plain has an elevation of less than 100 feet. Within the narrow fringe along the Piedmont border elevations up to 400 feet are reached, with here and there conspicuous groups of outlying hills. The Pleasant Hills of northern New Jersey, for example, rise to an elevation of 391 feet. The highest point on the Atlantic coast south of Maine is reached in the Highlands of Navesink on the New Jersey coast, with an elevation of 276 feet within a mile of the ocean. This is the only conspicuous coast elevation of the Atlantic seaboard, with the exception of the narrow strips of sand dune which stand out prominently in places. Over most of the North Atlantic Coastal Plain the land rises gradually from the lower beach dunes or salt marshes to within a short distance of the inner border, where there is usually a rather sudden ascent to the higher Piedmont hills. The topography east of this rolling inner rim is prevailingly undulating to gently rolling.

Fringes of low, flat estaurine terraces in many places border the shores of the larger bodies of water, such as Chesapeake and Delaware Bays, and the lower embayments of streams which enter them. The long, narrow "river necks," or peninsulas, usually flat topped, developed between the frequent rivers and creeks entering the estuaries constitute a distinctive feature of the North Atlantic forelands. The estuarine terraces are usually marked along their outer margins by distinct scarps, separating them from the adjacent higher land. The greater part of the Maryland-Delaware-Virginia peninsula is almost flat to gently rolling. It is mainly a terraced region, the higher elevations being reached by gently sloping to undulating terraces or plains. That portion of "Tidewater Virginia" to the west of the Flatwoods is gently rolling to hilly near the outer border, or about the same topographically as southern Maryland away from the terraced topography of the Chesapeake and Potomac forelands.

In North and South Carolina the Coastal Plain swings far west of the 100-foot elevation line, overlapping the Piedmont rocks at an altitude ranging from 300 to 450 feet. In this section the slope over a distance of about 75 miles between the Piedmont and the Flatwoods border ranges from 3 to 6 feet to the mile. This portion of the Coastal Plain, with few unimportant exceptions, is characterized by undulating to gently or moderately rolling topography. There are but few broken hills and ridges and only a small extent of severely eroded land.

Essentially the same topography of moderate relief and undissected slopes prevails over the greater part of the inner Coastal Plain of Georgia and eastern Alabama. The Piedmont border in this section averages considerably higher than to the north, a few points attaining an elevation upward of 700 feet. The distance from the margin of the Flatwoods, however, is much greater than in the regions to the north, making the gradient very nearly the same.

A strip of low to moderately high, irregularly arranged sand hills, from 5 to 30 miles wide, borders the Piedmont almost uninterruptedly from the vicinity of Sanford, N. C., to the vicinity of Auburn, Ala. Locally the region is known as "The Sand Hills," on account of the peculiar hillocky to hilly topography and the excessively sandy texture of the soils. Another region of peculiar surface character is comprised in the "Lime Sink" section of southeastern Georgia and western and central Florida. The abundance of rounded and elongated sink holes or sink-hole depressions lends a distinctive character to the surface of this general region. In the country about Gainesville and Ocala, Fla., there is developed an unusually broken topography, where there are no streams and no continuous ridges. Throughout the lime-sink country the greater part and occasionally all of the surface drainage finds its way through subterranean passages into the limestone platform underlying the region. Streams frequently disappear beneath the surface, reappearing in other locations.

In the vicinity of Appalachee and Mobile Bays the rolling Coastal Plain begins very close to or borders the waters of the Gulf, there being no important intervening strip of flat country such as elsewhere characterizes nearly the entire seaward border of the Gulf and Atlantic Coastal Plain south of New York.

A rather broad belt beginning in southwestern Alabama, to the west of Greenville, crossing into Mississippi, and extending northwesterly in a wide curve to the border of the loessial soils in the vicinity of Kosciusko, embraces an extensive area of hilly and badly dissected land which is too rough for profitable cultivation. South of this strip of rough country the surface is generally moderately rolling and well suited to tillage, although occasional sections are too hilly and gullied for the easy maintenance of a profitable agriculture.

To the north of the rolling belt of southwestern Alabama and central Mississippi is a curved strip of moderately rolling to rolling topography which includes little or no land too rough for cultivation. Still another curved belt of flat to undulating and gently rolling country ("Flatwoods") adjoins this on the north, and, again, to the north of this, comes in the "Black Prairie" belt, comprising a strip of flat to undulating or gently rolling mixed "post-oak" and prairie land about 25 miles in width, which swings in a curved line from the vicinity of Union Springs, Ala., through Macon, Miss., to the Tennessee line near Corinth. Between the black prairie section and the higher lands of the Appalachian and Piedmont regions the country becomes more rolling as the line of contact is approached, the hills rising to elevations of 500 to 600 feet. The former more uniform character of this inner border of the Coastal Plain has been almost completely obscured here through long-continued and active erosion, the original plains features having given way to irregular high hills and ridges, steep sloped and separated by gorge-like valleys. A considerable proportion of this border belt is too uneven for profitable agriculture, especially along the Appalachian Mountain border.

West of the Mississippi River the surface features of the Coastal Plain correspond closely with the main characteristics of that portion of the province lying east of the river. There is a broad strip of flat country bordering the coast which rises within a distance varying from 25 to 100 miles to an elevation of nearly 100 feet, and above this line an inner division which stretches away toward the higher *hinterland* with a varied topography of flat and gently undulating prairies to hilly and ridgy marginal fringes.

In Louisiana and eastern Texas small circular mounds of unknown origin are of frequent occurrence, often giving the surface, which is otherwise flat or undulating, a billowy or bumpy appearance. A large part of north-central and central Texas is occupied by the "black belt," which comprises something like 40,000 square miles of flat to undulating and occasionally rolling prairies, of somewhat triangular shape, extending from the Red River as the base southward to an apex in the vicinity of San Antonio. The western limits of the Coastal Plain border the higher region of the Permian Red Beds and the residual prairies of southwest Texas. This western margin possesses the rolling topography characteristic of the inner border of the entire province, although here the unevenness is probably greater, in places at least, than elsewhere.

The entire inner Coastal Plain division is for the most part well drained. Streams are numerous and of nearly the same character throughout the entire belt. They have a moderately strong current and broad first bottoms, some of which are more than 10 miles in width. A well-developed feature in connection with the drainage system of Alabama and Mississippi is the presence of one or more conspicuous old alluvial terraces along nearly all the important streams. These terraces, representing old first bottoms of streams along which they are developed, now stand above overflow. Some of them are several miles in width, and in places reach elevations of more than 100 feet above the first bottom. Both stream and marine terraces are conspicuous in Virginia, while marine terraces are one of the most prominent features of the water-foreland topography in the Maryland-Delaware-New Jersey section.

Notwithstanding the local diversity throughout the vast extent of the Atlantic and Gulf Coastal Plains province, a fairly close similarity in surface features, drainage characteristics, and soil-forming materials is maintained over the corresponding sections of the general region.

GEOLOGY.

The Atlantic and Gulf Coastal Plains province constitutes a vast outwash plain built up by material carried down by the regional drainage from the older mainlands to the rear (the Piedmont Plateau, the Appalachian Mountains and Plateaus, the Limestone Valleys and Uplands, the Glacial and Loessial, and the Residual Prairie regions) and deposited in former coastal waters through a long period of time under varying conditions of sedimentation. The component particles of the Coastal Plain soils were subject to the abrasive action of running water in their progress to the sea, where they were assorted and deposited, the heavier, coarser particles being laid down close to shore and the finer silt and clay carried out into deep water. Here the particles were again ground and worn upon each other by the agitation of tides and waves, and the less resistant thus finely comminuted. Through the action of sea water there has resulted an extensive assorting of the sedimentary materials, which range from the coarsest gravel and sand to the finest silt and clay, and under the powerful abrasive action of running water, tides, and waves, coupled with the strong solvent power of water, the less-resistant minerals have been worn down to silt and clay or dissolved, leaving the harder particles, chiefly quartz, as the dominant constituent of the Coastal Plain soils.

These wearing and dissolving forces, coincident with the formation of the Coastal Plain soils, have in all cases, regardless of geologic age, tended toward a simplification in the mineralogical constitution of the soils and the destruction of all but the hardest particles. Water thus had acted in the dual rôle of simplifying mineral constitution and magnifying textural complexity of the coastal sediments at the time of their uplift.

While it is not possible to trace the origin of any soil type of the Coastal Plain to a particular rock because of the transformation and mixing of the original particles, there are present in some regions certain constituents which can be traced to definite interior regions. Furthermore, certain soils, from these positions, obviously have been derived, in part at least, from one or more of the older soil provinces. In a general way the physiographic position of the Coastal Plain with reference to the regions to the rear indicates the general regional source of the original material.

The position of that section of the Coastal Plain to the north of the Potomac River and along the shores of the Chesapeake Bay with reference to the main drainage lines from the north, the Hudson, Delaware, and Susquehanna Rivers, is such as to make it obvious that probably the greater part of the material is composed of the mixed wash from all the soils of the drainage basins of these streams. This would include material from the glacial region, the Appalachian Mountains, the Limestone Valleys, and the Piedmont Plateau. There is no other position of the Coastal Plain province where the source of the material can be the same in so far as shown by present land forms, soil provinces, and drainage systems. The fact that the dominant soils here, the Sassafras group, occur in no other part of the Coastal Plain is strongly suggestive that similar conditions as to origin of material have not previously existed elsewhere in the region. Ice-borne bowlders weighing several tons are not uncommon over the Coastal Plain of the eastern shore of Maryland at a distance of 75 to 100 miles south of the Piedmont border.

Southward from the Potomac River and Chesapeake Bay to the vicinity of the Alabama River the Coastal Plain sediments have been largely derived, as judged by the position of the region with reference to interior soil provinces, from the soils of the Piedmont Plateau and Appalachian Mountains, modified somewhat by limestone material in the section between the Potomac and Roanoke Rivers, where the streams have their sources in the Limestone Valleys. Chert gravel is not present in any conspicuous amount south of the Roanoke River until the region in which drainage from the Limestone Valleys is reached. This absence of chert indicates the absence of limestone material from the soils of this part of the Coastal Plain. From the Alabama River section to the loessial belt bordering the Mississippi bottoms east of the river, beneath which the Coastal Plain deposits disappear, chert gravel is abundant, furnishing proof of the presence of limestone material and indicating the Appalachian Mountains and Limestone Valleys to the north and northeast as being the chief regional sources of the soil material.

A group of soils such as the Crowley, Acadia, and Landry, occurring in the smooth, low country skirting the Mississippi bottoms, which has been classed as belonging to the Coastal Plain, are prevailingly high in silt. This silt content, together with the location of the soils with respect to the Mississippi River, suggests that much of the material had its source in the glacial and loessial regions to the north, having been conveyed to its present position by the Mississippi.

The soil forming the material of the Coastal Plain west of the Mississippi River in the eastern division is doubtless derived chiefly from the soils of the Ozark Uplift, while that of the central and western portions undoubtedly came from the soils of the Residual Prairie region.

In addition to the variation in the character of the Coastal Plain sediments, due to the different sources of origin, and the degree of comminution and elutriation as determined by distance transported and the conditions governing deposition, still other divergencies have resulted from the deposition of matter carried in solution, particularly calcareous material, through the interposition of marine life. The remains of shellfish and other forms of sea life carrying lime extracted from the water constitute the bulk of the calcareous material found in the various marls and soft and hard limestones throughout the province.

There were probably emergences and resubmergences of the sea floor during the building of the Coastal Plain, and there undoubtedly were variations, from time to time, in the source of the material and in the manner of its deposition. Possibly some of the material was simply washed down from the land areas and spread out as broad alluvial fans. At any rate the Coastal Plain province comprises a succession of belts representing geological formations of different age, in most of which there is some distinctive peculiarity of topography, structure, or component material. The older deposits constitute the interior belts which conform in direction with the outer rims of the older rear-land areas. Later deposits were laid down successively over the older ones, and each belt has a general slope, either toward the present coast or toward the coast as it existed immediately subsequent to the period of deposition. Thus, along the Atlantic coast the slope is to the east and south, in Alabama it is almost due south, along the Mississippi it is toward the bottoms on both sides, and in Texas it is toward the shores of the Gulf of Mexico. All the geological formations represented in the Coastal Plain do not reach the surface everywhere, since in some instances they have been covered by later deposits and in others removed by erosion.

SOILS.

Since the final emergence of the Coastal Plain deposits many changes have taken place. These represent mainly the effects of oxidation, percolation, and running water, and modifications due to the action of organic life. Oxidation, governed largely by drainage conditions and porosity of the deposits, has been largely instrumental in the development of the many shades of red, yellow, and brown presented in the varied soils of the region. Accumulated decaying vegetation accounts for the black and dark-gray colors, while the leaching effects of percolating and running water and the consequent inhibition of oxidation through the exclusion of air are mainly responsible for the gray and white colors of the soils. Percolating water has assisted in carrying the finer particles from the surface zone down to greater depths, while running water has

been a powerful agent in changing the texture of the original deposits over local areas by washing out the finer particles. The degree of textural change through the removal of the finer particles has depended considerably upon the local character of the topography. On ridges and slopes the fine material has washed more completely and to a greater depth than on the level areas, leaving deep sand beds.

Drainage has been the determining factor in the development of the soils of the Flatwoods and has governed the degree of weathering, which has consisted chiefly of the oxidation of the contained iron and salts and the accumulation of organic matter in the soil.

In the semiarid western portion of the province, where the materials have been brought down from regions of soils having a high salt content, the low rainfall has not favored the leaching out of the soluble salts. As a result the soils contain more water-soluble salts than is the case in the humid portion of the provinces, where excessive leaching has been a natural corollary of the heavy rainfall.

While most of the soils of the Coastal Plain have probably been derived from unconsolidated sedimentary material, there is a large aggregate area which represents the residual products from the decay of consolidated sediments, such as the hard limestones of Florida and Georgia and the soft and hard limestones of Alabama, Mississippi, and Texas.

The most important soil series of the North Atlantic Coastal Plain are the sandy members of the Sassafras, Elkton, and Collington. The Sassafras soils are by far the most important in extent and agricultural value. South of the Chesapeake Bay and Potomac River the sands, sandy loams, and fine sandy loams of the Norfolk series embrace the greater proportion of the area to the latitude of central South Carolina. These soils are also of much importance throughout the entire region west of this point to the Mississippi loessial belt. West of the Mississippi the Norfolk continues as a fairly important series, especially the sand types. In the Flatwoods belt the sands, fine sandy loams, sandy loams, clay loams, and silt loams of the Portsmouth, Coxville, Scranton, and Plummer series constitute the most important soils. These are types of poor to only moderate drainage.

The sandy Norfolk and Orangeburg soils are of about equal extent and importance over the inner Coastal Plain from the latitude of central South Carolina to the Savannah River. Between the Savannah and Chattahoochee Rivers the sandy members of the Tifton, Orangeburg, and Norfolk are the most extensively developed soils above the Flatwoods border, with the exception of the lime-sink section of southwest Georgia, where the Greenville, Grady, Tifton, and Orangeburg are the prominent series, with a range in texture of the important types from coarse sand to clay loam. That portion of the Flatwoods lying within southeast Georgia and Florida is occupied to a large extent by the deep, sandy Leon soils, which give the region its dominant white surface appearance. The Leon and Portsmouth sands are very extensive soils throughout the Florida peninsula, north of the Everglades region. Central Florida includes large areas of heavy and sandy residual limestone soils, represented chiefly by the Gainesville and related series.

The western panhandle of Florida and that portion of southern Alabama and Mississippi lying approximately between the Flatwoods and the latitude of Hattiesburg, Miss., is occupied largely by the sandy members of the Norfolk, Ruston, and Orangeburg series and both the heavy and sandy types of the Greenville, with a fair area of heavy Susquehanna and light Tifton soils. The Susquehanna, Norfolk, Ruston, and Orangeburg, with heavy and light members, are the important series of northern Alabama and Mississippi, with the exception of the heavy Houston and Oktibbeha soils, occupying the greater portion of the Black Prairie belt of central Alabama and northeastern Mississippi.

The low Coastal Plain country bordering the Mississippi bottoms in southern Louisiana, southeast Texas, and southeast Arkansas is dominated by the mixed prairie and timbered, silty soils of the Crowley, Acadia, Monroe, and Landry series. In eastern Texas, above the low Coastal Prairies, and in southeastern Arkansas the light and heavy grades of the Susquehanna, Caddo, and Norfolk soils constitute the most important land areas, while in central Texas these, with the heavy, calcareous soils of the Crockett and Wilson series, are collectively the most important. The western portion of the Texas Coastal Plain comprises mainly the heavy members of the Houston and Webb series. In the flat coastal belt the heavy Victoria and Lomalto soils are the most prominent.

The soils of the Atlantic and Gulf Coastal Plain provinces are thus seen to be very diversified. They comprise a sufficient range in texture and climate to support a highly varied agriculture. There are included a tremendous area of medium to excellent general-farming soils and vast tracts of special-purpose soils preeminently adapted to highly specialized industries requiring the most intensive and expensive methods of cultivation.

A large portion of the soils are predominantly sandy, easy to cultivate, and outside of the low coastal belts, usually well drained. Their open structure makes for thorough aeration, with consequent susceptibility to severe leaching and rapid depletion of the organic content. Where properly supplied with organic matter, fertilized, and cultivated, millions of acres of these sandy lands are being profitably used in the production of a great variety of crops, such as cotton, corn, oats, forage crops, peanuts, a large number of vegetables, melons, small fruits, peaches, plums, oranges, and pineapples.

There are also within this province large areas of fine-textured soils that require heavier implements and equipment. These are not so rapidly depleted, partly for the reason that they are not so readily leached nor so thoroughly aerated, requiring less heavy fertilization than the sandier lands.

CLIMATE.

The climate ranges from the subtropical immediately along the Gulf coast to the moderately temperate in the latitude of New York. The soils are favored in their proximity to the Ocean and Gulf, which insures a warmer and more equable winter and spring climate than is found in other parts of the eastern half of the United States. For these reasons they have a monopoly of the markets of a very large part of the country for fresh vegetables and fruits for six months of the year, or from about January 1 to July 1. On account of the great range in latitude—over a thousand miles in actual distance—and the rather slow advance of spring northward, as well as the difference in time of maturity of crops on the different grades of soil, as indicated in subsequent pages, a constant daily supply of fresh, perishable vegetables and fruits is poured into the northern markets during the first half of the year. After this period the season has advanced to a point where the supply is drawn in a similar progressive manner from the various types of soil belonging mainly to the glacial-soil provinces.

An idea of this progressive movement of the sources of supply of vegetables, due both to the advance of the season from south to north and to the influence of soil texture, is given in the following table:

Market periods for fresh vegetables for the six months January to June, and the relative order of the supply from localities and from different soil types in each locality.

Locality.	First period.	Second period.	Third period.	Fourth period.	Fifth period.	Sixth period.
Long Island						Sand.
Maryland and Delaware					Sand	Fine sand.
Virginia				Sand	Fine sand	Sandy loam.
North Carolina			Sand	Fine sand	Sandy loam.	Fine sandy loam.
South Carolina		Sand	Fine sand	Sandy loam.	Fine sandy loam.	Loam.
Georgia and Florida	Sand	Fine sand.	Sandy loam.	Fine sandy loam.	Loam	Silt loam.

Each of the localities named can in normal seasons count on a margin of 10 days to 2 weeks advance in crop maturity over the locality next in order to the north within which crops can be marketed at the greatest profit. There is, furthermore, a similar interval of 10 days to 2 weeks in the time of maturity of crops on the several different classes of soil existing under similar conditions of drainage in the districts named. The earliest vegetables come from the light, porous, well-drained, and warm, dry sands. The yields from such very early soils are light unless heavily fertilized; the quality of certain of these crops is not, as a rule, the best. A number of the rapidly grown vegetables from these soils are perishable and do not stand transportation well, both on

account of poor quality and the tendency of the truckers to ship in an immature state. They usually bring high prices, however, because of the great demand and the limited supply on the markets.

The crop from the fine sand maturing about 10 days later gives a larger yield, which compensates for the earlier entrance into the markets of the products from the more sandy soils of the next northern locality. Georgia, for example, can not compete in the northern markets with truck grown on her heavier soils, simply because at the time it matures there is such a wide range of soils in more northern localities rushing vegetables over an ever decreasing length of haul to the great markets.

Conditions with respect to the soils of Texas and Louisiana are somewhat different in that they can continue for a longer time to supply the great markets of the Middle West, including Chicago, St. Louis, Kansas City, Omaha, St. Paul, and Minneapolis, as there is less competition from more northern localities and a wider textural range of soil types which can be used for early vegetables than can profitably be used in the more eastern and northern parts of the province.

Throughout the humid portion of the province, which comprises the major portion of the region lying to the east of central Texas, general and specialized farming are conducted upon approximately the same general lines. Certain crops with their peculiar methods of culture, however, are confined to different ranges of temperature, as for example the citrus fruit industry, which is restricted to the Gulf border. Rice and sugar cane are confined to the Gulf States, Georgia, and South Carolina; cotton to the south of the latitude of Norfolk, Va.; timothy to the north of Norfolk. Crops like corn, cowpeas, and vegetables can be successfully grown under the same methods of treatment from Texas to New York. In the semiarid western portion of the provinces irrigation is necessary for best results with all crops, but certain drought-resistant plants, such as cotton, sorghum, milo maize, and kafir corn are grown with better results than the more susceptible crops such as corn, wheat, oats, and potatoes.

In addition to the limitations imposed by climate, the soil itself has a tremendous influence upon the success of agriculture in the Atlantic and Gulf Coastal Plain. The various types have unequal agricultural values and unlike adaptations, and should be farmed in accordance with their individual adaptations to crops.

Of the 60,119,138 acres surveyed in the Atlantic and Gulf Coastal Plains province, there are 2,209,536 acres where the material or series is known, but the types have not been differentiated, and 1,845,342 acres of miscellaneous material.

There have been 39,150,626 acres surveyed on the detail scale of an inch to a mile, and 22,420,224 acres on the reconnoissance scale of 4 to 6 miles to the inch in Texas, from the total of which must be deducted 1,451,712 acres which have been overlapped in the maps as published.

Of the 56,064,260 acres of soil types and phases which have been differentiated, the following table shows the amount and proportion of each grade of material:

Grade.	Acres.	Per cent.	Grade.	Acres.	Per cent.
Sands	5,230,016	9.3	Silt loams	2,284,562	4.0
Fine sands	6,108,270	10.9	Clay loams	3,372,704	6.2
Sandy loams	7,681,334	13.7	Clays	6,744,830	12.0
Fine sandy loams	19,603,248	34.9			
Loams	5,039,296	9.0	Total	56,064,260	100.0

DESCRIPTION OF THE SOIL SERIES.

Acadia series.—The surface soils are light gray or white with mottled gray and yellow or gray, yellow, and red friable subsoils, carrying lime nodules and iron concretions. They are derived mainly from reworked loessial material. The surface configuration is gently rolling and is apparently the result of erosion of former prairie soils. The series is timbered with pine, oak, gum, hickory, and some cypress in the lower, poorer drained situations. The Acadia soils are typically developed in close association with the prairies of Louisiana and

Arkansas. They are best adapted to the production of cotton, corn, peas, and oats. Wild grasses and lespedeza can be grown for grazing purposes.

Area and distribution of the soil of the Acadia series.

Soil name.	State or area.[1]	Acres.
Acadia silt loam	Arkansas 4; Louisiana 1	225,792

[1] For key to numbers in this column see p. 733.

Alloway series.—The soils of this series are gray to reddish-brown. The subsoils consist of a gray, yellow, or mottled gray, yellow, and red, stiff, plastic heavy clay. The topography is nearly level to gently rolling, the country having rather poor drainage on account of the impervious subsoil. The soils are typically developed in the Coastal Plains of New Jersey. They seem to be related to both the Elkton and Susquehanna series. By improving the drainage conditions fair yields of grass and grains can be secured.

Area and distribution of the soil of the Alloway series.

Soil name.	State or area.[1]	Acres.
Alloway clay	New Jersey 1, 3	22,484

[1] For key to numbers in this column see p. 733.

Beeville series.—This series has light-gray surface soils with gray or mottled gray subsoils of plastic, sticky clay. The soils occupy terrace-like areas along streams, probably representing an inland extension of the Pleistocene formation of the flat coastal region of southwest Texas. Little of the land is under cultivation, the greater part supporting a growth of mesquite, chaparral, and live oak, with some grass. The agricultural value is prevailingly rather low, the general farm crops not doing well. In years of favorable rainfall early truck crops have been grown.

Area and distribution of the soil of the Beeville series.

Soil name.	State or area.[1]	Acres.
Beeville fine sandy loam	Texas 12, 28	117,504

[1] For key to numbers in this column see p. 733.

Berzelia series.—These soils are marked by their grayish to almost white color and by the yellowish to white color and chalky character of the subsoil, which consists principally of kaolin, with a scattering of mica flakes. The material represents clays and clay shales encountered in various places on the Piedmont Coastal Plain border and used in the manufacture of kaolin products. The soils are of low agricultural value.

Area and distribution of the soils of the Berzelia series.

Soil name.	State or area.[1]	Acres.
Berzelia coarse sandy loam	Georgia 5	3,712
silt loam	do	832
Total		4,544

[1] For key to number in this column see p. 733.

Bienville series.—The soils of this series are gray to light brown, with light brown or orange colored subsoils. They are derived from reworked loessial material. The types occur as hummocky areas in or adjacent to the recent stream deposits, but are seldom if ever overflowed. They are fairly productive soils, suited to trucking and general farming.

Area and distribution of the soils of the Bienville series.

Soil name.	State or area.[1]	Acres.
Bienville fine sand	Texas 9	384
fine sandy loam	Louisiana 2, 9	6,336
Total		6,720

[1] For key to numbers in this column see p. 733.

Bladen series.—This series is characterized by a thin mantle of gray to black surface soil. The subsoils consist of mottled brownish, yellow, and gray heavy plastic clay. The members occupy flat depressions which appear to have been recently under tidal marsh conditions. The series is apparently intermediate between Tidal Marsh and the Coxville soils. It differs from the latter in not being so well drained and in the absence of red in the subsoil. The members are characteristically developed in close association with Tidal Marsh and have been very little used for agriculture. The soils are derived from the reworking of Piedmont-Appalachian material.

Area and distribution of the soils of the Bladen series.

Soil name.	State or area.[1]	Acres.
Bladen sandy loam	Georgia 10	2,048
fine sandy loam	do	14,592
very fine sandy loam	do	960
clay loam	do	19,776
clay	Georgia 3	3,648
Total		41,024

[1] For key to numbers in this column see p. 733.

Boeuf series.—The surface soils are brown, with yellow plastic subsoils. The members occupy low areas in the vicinity of drainageways, and are usually found associated with the loessial soils. They are derived from Piedmont-Appalachian material. Where the loessial mantle has been removed good yields of cotton and corn are obtained. These soils should be well suited to vegetables.

Area and distribution of the soil of the Boeuf series.

Soil name.	State or area.[1]	Acres.
Boeuf fine sandy loam	Louisiana 6	320

[1] For key to number in this column see p. 733.

Bradley series.—The surface soils are grayish and sandy. The subsoils are predominantly red, slightly mottled with yellow or gray, and have a clay texture. The series represents soils having a thin surface mantle of Coastal Plain material (Norfolk) over residual Piedmont material (mainly Cecil). These soils are developed most extensively near the junction of the Coastal Plain and Piedmont, or in that region where there is an overlapping of sedimentary material made up of reworked Piedmont-Appalachian material upon residual Piedmont material. They are adapted to the general farm crops of that region, principally corn, oats, forage crops, and cotton.

Area and distribution of the soils of the Bradley series.

Soil name.	State or area.[1]	Acres.
Bradley sandy loam	Alabama 8; North Carolina 15, 23; Virginia 5	76,992
gravelly sandy loam	Alabama 8, 14; North Carolina 15	23,232
coarse sandy loam	Georgia 5	10,560
Total		110,784

[1] For key to numbers in this column see p. 733.

Brennan series.—This series consists of gray calcareous soils containing a small amount of humus and a large amount of lime. They have been derived from Pleistocene deposits occurring in broad valleys of the inner Gulf Coastal Plains. The soils are closely related to both the Zapata and Victoria series. The more level topography, absence of greater depth to the underlying rock, and a higher agricultural value are the striking features of this series as compared with the former. The lighter color, larger lime content, and smaller percentage of humus distinguish these from the Victoria soils.

Area and distribution of the soils of the Brennan series.

Soil name.	State or area.[1]	Acres.
Brennan fine sandy loam	Texas 27	1,108,224
loam	do	142,848
undifferentiated	Texas 28	142,848
Total		1,393,920

[1] For key to numbers in this column see p. 733.

Caddo series.—The soils are gray to yellow in color. The subsoils are mottled gray and yellow, or gray, yellow, and red, and of rather stiff structure. Low, sandy mounds or hummocks over the surface are a feature of the series. In some places the subsoil has a pronounced grayish color, while in others it is mottled yellow and gray. These soils are typically developed in slightly depressed upland areas of imperfect drainage, frequently about the heads of streams. Some areas occupy higher situations and have better drainage. Water frequently stands in the depressions between the mounds, making artificial drainage necessary to secure the best results with crops. The timber growth consists principally of post oak, water oak, pin oak, sweet gum, and ash. Cotton and corn are the principal crops, while peaches have been grown with a fair degree of success on some of the higher areas. These soils are most extensively and typically developed in northwestern Louisiana and northeastern Texas, where loessial material has been reworked and spread out.

Area and distribution of the soils of the Caddo series.

Soil name.	State or area.[1]	Acres.
Caddo fine sand	Louisiana 8	13,970
fine sandy loam	Louisiana 3, 8, 9, 14; Texas 6, 10, 13, 29	172,028
loam	Louisiana 8	51,280
Total		237,278

[1] For key to numbers in this column see p. 733.

Chesterfield series.—The soils are generally gray in color, with friable, yellow subsoils. The series represent soils having a thin layer of Coastal Plain material (Norfolk) overlying residual Piedmont material (mainly Durham). The members are developed near the junction of the Coastal Plain and Piedmont, or where there is an overlapping of sedimentary upon residual

material. They are adapted to the general farm crops of the region, principally corn, oats, forage crops, and cotton.

Area and distribution of the soils of the Chesterfield series.

Soil name.	State or area.[1]	Acres.
Chesterfield sandy loam	Virginia 5	95,680
gravelly sandy loam	Alabama 14; Virginia 5	52,480
Total		148,160

[1] For key to numbers in this column see p. 733.

Collington series.—The surface soils are brown to reddish brown in color. The subsoils are dark green to olive green and contain larger quantities of glauconitic sands. These soils are typically derived from the greensand deposits of the Maryland, Delaware, and New Jersey portion of the Coastal Plains, extensively modified by deep sea accretions, and are found in the key under Glacial-Piedmont-Appalachian material. The surface configuration varies from nearly flat to gently rolling and drainage is good. In some places erosion has been active, exposing patches of unproductive clay. When properly handled and supplied with organic matter good yields of wheat, corn, oats, rye, tobacco, Irish potatoes, sweet potatoes, and a number of vegetables are obtained. Strawberries, pears, and peaches have been successfully grown. The series is especially well suited to the growth of nursery stock.

Area and distribution of the soils of the Collington series.

Soil name.	State or area.[1]	Acres.
Collington sand	Maryland 1	1,216
sandy loam	Maryland 1, 8; New Jersey 1, 3	152,486
gravelly sandy loam	Maryland 1	320
Total		154,022

[1] For key to numbers in this column see p. 733.

Coxville series.—The series comprises dark gray to nearly black soils derived from the quiet or deep water deposits of the Columbia formation. The subsoils range from a moderately mellow, friable clay in the upper portion to yellowish, rather plastic, compact clay mottled with drab and bright red in the lower portion. The topography is prevailingly flat, with frequent sparsely timbered areas. The treeless lands are found on the savannas of the seaward portion of the Atlantic Coastal Plain formed of material brought down by the larger rivers from the Piedmont-Appalachian region. Most of the types are so flat that water stands on the surface, making open ditching necessary before they can be successfully used for agriculture. The soils are admirably adapted to cotton, corn, oats, and certain varieties of strawberries. When well drained they are even more productive than the corresponding members of the Norfolk series.

Area and distribution of the soils of the Coxville series.

Soil name.	State or area.[1]	Acres.
Coxville very fine sand	Georgia 3	3,904
sandy loam	South Carolina 10	14,336
coarse sandy loam	Georgia 3	15,552
fine sandy loam	South Carolina 7, 10	150,784
very fine sandy loam	Georgia 3, 10; South Carolina 7	38,016
silt loam	North Carolina 21; South Carolina 7	17,408
clay loam	Georgia 2; North Carolina 25; South Carolina 10	22,144
clay	Georgia 3; South Carolina 7, 10	17,280
Total		279,424

[1] For key to numbers in this column see p. 733.

Crockett series.—The surface soil is gray to dark gray and sometimes almost black, with mottled red, gray, and black subsoils, the red mottling being the distinguishing characteristic. The members of this series occur as isolated prairies in the timbered part of Texas. The series may be considered as representing a gradation from the black prairie soils of the Houston to the mottled red clays of the Susquehanna series. The material from which they are derived is slightly calcareous, making them productive.

Area and distribution of the soils of the Crockett series.

Soil name.	State or area.[1]	Acres.
Crockett fine sandy loam	Texas 24	4,416
loam	Texas 3, 25, 28	28,288
gravelly loam	Texas 24	3,008
clay loam	Texas 3, 14, 24	21,440
Total		57,152

[1] For key to numbers in this column see p. 733.

Crowley series.—The soils range from ashy gray to light brown in color, with mottled brown, yellow, and red to almost uniformly yellow clay subsoils. Lime and iron concretions are present in the subsoil, which is quite impervious to water. This feature favors the production of rice. The surface configuration is very flat. These are the typical prairie soils of Louisiana and Arkansas, formed of reworked loessial material.

Area and distribution of the soil of the Crowley series.

Soil name.	State or area.[1]	Acres.
Crowley silt loam	Arkansas 4, 5; Louisiana 1	477,120

[1] For key to numbers in this column see p. 733.

Durant series.—The series consists of dark gray to dark brown surface soils, with yellow to dark brown subsoils. The members are derived from soft sandstone and calcareous marl, the material being originally derived from the Great Plains. The heavier soils were originally prairie lands and some of the more sandy types supported a timber growth. The soils are productive, giving fair yields of general farm crops.

Area and distribution of the soils of the Durant series.

Soil name.	State or area.[1]	Acres.
Durant sand	Oklahoma 2	4,288
fine sand	Texas 11	1,600
fine sandy loam	Oklahoma 2; Texas 9, 11	89,856
very fine sandy loam	Texas 9	2,752
loam	Texas 9, 11	73,216
clay	Texas 9	39,936
Total		211,648

[1] For key to numbers in this column see p. 733.

Duval series.—These soils are marked by their bright red color and rather low lime content. The series is the semiarid equivalent of the Orangeburg soils of the humid areas of the Coastal Plains, being derived from fluvial deposits of red sands and sandy clays closely resembling the Lafayette formation of the southeastern United States. The members are less calcareous than the Webb soils, the red of the subsoil being more pronounced.

Area and distribution of the soils of the Duval series.

Soil name.	State or area.[1]	Acres.
Duval fine sand	Texas 27, 28	709,632
fine sandy loam	do	2,240,960
loam	Texas 28	214,272
undifferentiated	Texas 12, 28	297,216
Total		3,462,080

[1] For key to numbers in this column see p. 733.

Edna series.—The soils of this series are gray to dark gray. The subsoils consist of gray or mottled gray and yellow, heavy, impervious clay. The surface is level to gently undulating, with some slightly rolling areas near stream courses. Small sand mounds are of frequent occurrence. These soils are derived from the weathering of noncalcareous marine deposits in the Coastal Prairie section of the Western Gulf Plain. Drainage is often poor, and the greater part of the series is now used for pasturage. While the soils are not inherently productive, fair to good yields of the general farm crops can be obtained with good drainage and careful soil management. Cotton, corn, and other general farm crops are grown to some extent. Vegetables do well on the lighter types. The supply of organic matter is prevailingly low. Liberal additions of vegetable matter are necessary to maintain the productivity of the soils.

Area and distribution of the soils of the Edna series.

Soil name.	State or area.[1]	Acres.
Edna fine sandy loam	Texas 12	1,248,768
loam	do	209,664
clay loam	do	73,728
Total		1,532,160

[1] For key to number in this column see p. 733.

Elkton series.—The soils are light gray to white, and the subsoils are mottled whitish gray and yellow. Gravel or coarse sand, usually saturated with water, is found at a depth of 2½ to 3 feet. These soils are closely associated with the Sassafras, the difference being due to the intermittent wetting and drying to which the Elkton soils have been subjected, rendering them much lighter in color and lower in agricultural value. They are encountered in that part of the Coastal Plain which has been supplied with Glacial-Piedmont-Appalachian material.

Area and distribution of the soils of the Elkton series.

Soil name.	State or area.[1]	Acres.
Elkton sandy loam	Maryland 4	9,280
fine sandy loam	Virginia 5	14,656
loam	Maryland 4	2,624
silt loam	Delaware 1; Maryland 1,3,4,5,6,8,10; New Jersey 1; Pennsylvania 6.	168,468
Total		195,028

[1] For key to numbers in this column see p. 733.

Ellis series.—These soils are yellowish brown, with yellowish subsoils formed from marly clays or similar calcareous material. The topography varies from rolling to hilly and broken. For this reason the soils are usually of rather low agricultural value.

Area and distribution of the soil of the Ellis series.

Soil name.	State or area.[1]	Acres.
Ellis clay	Texas 9	18,880

[1] For key to number in this column see p. 733.

Gadsden series.—This series includes the dark-gray soils encountered on gentle or undulating slopes adjoining streams and on level or depressed areas in the uplands. Their formation is due largely to the peculiar topographic conditions resulting from the sinking of the limestone which in some areas underlies the material from which the Norfolk and Orangeburg soils have been derived. They may be considered as colluvial soils, formed by the creeping or washing of material from higher lying areas. They constitute valuable farming soils, so far as mapped.

Area and distribution of the soils of the Gadsden series.

Soil name.	State or area.[1]	Acres.
Gadsden sand	Florida 2, 5, 6; Georgia 1	54,784
sandy loam	Florida 5, 6	6,592
loam	Mississippi 11	14,592
Total		75,968

[1] For key to numbers in this column see p. 733.

Gainesville series.—The soils of this series are prevailingly gray in color, with brownish colored subsoils, which carry calcareous clay or partly weathered limestone within the 3-foot section. These soils are sometimes locally known as "chocolate hammock land," or "second hammock land," and are developed most extensively in the rolling uplands of the Florida peninsula. The native timber growth consists of large scattering pines, interspersed with hickory and several varieties of oak. The natural drainage is good. Corn, oats, peanuts, and Sea Island cotton are the important products. The soils are shown in the key under Piedmont-Appalachian material.

Area and distribution of the soil of the Gainesville series.

Soil name.	State or area.[1]	Acres.
Gainesville sand	Florida 3	7,744

[1] For key to number in this column see p. 733.

Glenn series.—The soils are gray to grayish yellow, with yellow, friable subsoils. These soils represent a thin layer of reworked Piedmont-Appalachian material resting upon sandstone and shale rock. Some residual material is occasionally encountered in the subsoils. The soils are characteristically developed in northern Alabama, where they occur as detached areas of gently rolling to rough topography. They are used principally for the production of the general farm crops of the region.

Area and distribution of the soils of the Glenn series.

Soil name.	State or area.[1]	Acres.
Glenn sandy loam	Alabama 27	73,600
loam	Alabama 10, 27	42,688
gravelly loam	Alabama 10	69,312
Total		185,600

[1] For key to numbers in this column see p. 733.

Goliad series.—These soils are prevailingly dark gray to black, with reddish brown to red sandy loam or sandy clay subsoils, in the lower portions of which a white soft calcareous substratum is encountered. In places this calcareous material has been consolidated into impure limestone. In their typical development these soils occupy gently rolling to moderately hilly areas in the Gulf Coastal Plain of Texas. The soil material consists of weathered marine deposits. Fair to good yields of the general farm crops are secured over areas of smoother topography and vegetables give good results.

Area and distribution of the soils of the Goliad series.

Soil name.	State or area.[1]	Acres.
Goliad gravelly sandy loam	Texas 12	16,128
fine sandy loam	Texas 28	172,800
undifferentiated	Texas 12	960,768
Total		1,149,696

[1] For key to numbers in this column see p. 733.

Grady series.—The surface soils of this series are generally dark colored, with mottled yellow and gray, or yellow, gray, and red plastic heavy clay subsoils, resting upon a limestone substratum. The subsoil is partly residual in places, derived from the underlying limestone. These soils are characteristically developed in low, flat situations in which Piedmont-Appalachian material predominates. They are poorly drained in wet seasons. The series is timbered with oak, beech, gum, magnolia, pine, and haw. Where properly drained good crops of corn, cotton, oats, and sugar cane can be secured.

Area and distribution of the soils of the Grady series.

Soil name.	State or area.[1]	Acres.
Grady fine sandy loam	Florida 7	1,536
loam	Georgia 11	896
Total		2,432

[1] For key to numbers in this column see p. 733.

Grayson series.—The series include dark gray to brown surface soils, and yellow or mottled yellow, stiff subsoils. The material is derived from reworked material from the residual prairies. The topography is generally level and the members known locally as "flats." Low ridges and knolls are occasionally developed over these flat areas, and in some places gullies have been formed as a result of erosion. Drainage is poor and little attempt is made to cultivate any of the different types.

Area and distribution of the soil of the Grayson series.

Soil name.	State or area.[1]	Acres.
Grayson clay loam	Texas 11	10,560

[1] For key to number in this column see p. 733.

Greenville series.—These soils are reddish brown to dark red, and generally loamy. The subsoils consist of red, friable sandy clay. The types occupy level to gently rolling areas in the Coastal Plains uplands. They are closely associated with the members of the Orangeburg series in their distribution and, like them, are derived, in part at least, from the Lafayette formation. The Eocene formation also seems to enter in places into their composition, while subsoils are influenced to some extent by the limestone that often underlies the series. As a rule the soils are more retentive of moisture than the corresponding mem-

bers of the Orangeburg series, being admirably adapted to cotton, corn, forage crops, and oats. Alfalfa could be produced successfully on the heavier members of this series. They are to be found in the key under Piedmont-Appalachian material.

Area and distribution of the soils of the Greenville series.

Soil name.	State or area.[1]	Acres.
Greenville coarse sand	Alabama 32	1,408
loamy sand	Alabama 9, 12; Florida 7; Georgia 15	161,664
fine sand	Alabama 9	2,432
sandy loam	Alabama 1, 2, 9, 12, 14, 18, 32, 37; Florida 7; Georgia 15; North Carolina 23.	201,664
gravelly sandy loam	Georgia 15; Louisiana 2, 9, 14	225,536
coarse sandy loam	Alabama 32	3,712
fine sandy loam	Alabama 1, 3, 5, 37; Georgia 8; Louisiana 9	60,544
loam	Alabama 2, 17, 29, 37; Florida 1; Louisiana 2, 9, 14; Mississippi 5, 8.	38,656
gravelly loam	Georgia 5	1,600
clay loam	Alabama 1, 5, 9, 12, 13, 25, 34; Georgia 15; Mississippi 8, 12, 15, 16; South Carolina 6, 16; Texas 1, 14, 15, 18, 21, 23.	369,024
gravelly clay loam	Georgia 15	5,760
clay	Florida 7	768
Total		1,072,768

[1] For key to numbers in this column see p. 733.

Guin series.—The Guin soils are predominantly gray and sandy in the surface section, and have yellowish red to red subsoils. They occupy hilly, broken uplands of the Coastal Plain, where erosion has been and still is very active. The members are usually marked by the presence of locally formed sandstone. There is generally such a lack of uniformity in these soils as to make separation of the various types difficult. In origin they are closely associated with the Orangeburg and Ruston series, but also include patches of Susquehanna soils usually too small to be satisfactorily differentiated from the Orangeburg, Ruston, and sometimes the Norfolk soils. All of these soils are frequently mapped under the Guin series owing to their intricate association and patchy occurrence. The agricultural value of the series averages low, as, owing to the rough topography, considerable areas are unsuited for other purposes than pasturage and foresty.

Area and distribution of the soils of the Guin series.

Soil name.	State or area.[1]	Acres.
Guin stony sand	Mississippi 20	7,232
fine sand	Alabama 3	2,304
sandy loam	Alabama 3, 14, 22, 37	34,176
stony sandy loam	Alabama 22, 27; Mississippi 9, 14	127,808
gravelly sandy loam	Alabama 3, 22, 27, Mississippi 10	93,760
Total		265,280

[1] For key to numbers in this column see p. 733.

Hammond series.—The surface soils are ashy gray to dark gray or brown, and the subsoils are mottled yellow, drab, or brown and red. Iron concretions are of common occurrence throughout the soil profile. The silt loam member of the series does not hold moisture well, baking in dry weather and becoming powdery or chalky and almost white. Stream courses are numerous, but their channels are so poorly developed that they have little influence upon drainage. Owing to the impervious nature of the subsoils water stands on the Hammond soils for long periods after heavy rainfall. The soils are more or less crawfishy. These lands are locally known as "pine flats," on account of their flat surface and the presence of longleaf pine. They are deficient in organic matter and are naturally poor. With the establishment of good drainage, oats do very well, while crab grass and sugar cane give fair yields. The soils differ from other somewhat similar types found in Louisiana and derived from reworked loessial material in the absence of sand mounds.

Area and distribution of the soil of the Hammond series.

Soil name.	State or area.[1]	Acres.
Hammond silt loam	Louisiana 13	70,976

[1] For key to number in this column see p. 733.

Harley series.—This series includes grayish surface soils, and mottled yellow, red, and drab, waxy, and tenacious subsoils. Quartz and feldspar derived from the underlying granitic rocks are common throughout the soil section. The subsoil is largely of residual origin. The soil types occupy low, rolling hills and slopes of small stream valleys, where drainage is good. Good yields of corn and cotton are secured, but the soils are probably best adapted to potatoes, truck crops, and small fruits.

Area and distribution of the soil of the Harley series.

Soil name.	State or area.[1]	Acres.
Harley sandy loam	Oklahoma 2	8,832

[1] For key to number in this column see p. 733.

Henderson series.—The members of this series are marked by their greenish-gray, sticky, and refractory clay subsoils and usually carry large amounts of limestone fragments and marly material in various stages of decomposition. The soils occur in patches as residual material, derived from exposures of Tertiary limestones. These soils have a low agricultural value, because of their intractable subsoils, which usually occur at shallow depths.

Area and distribution of the soil of the Henderson series.

Soil name.	State or area.[1]	Acres.
Henderson stony clay	Alabama 32	192

[1] For key to number in this column see p. 733.

Hoffman series.—The series consists of gray surface soils and pink or mottled pink, gray, and reddish, compact, subsoils. The subsoil material is partially cemented in places with iron salts, and carries white, floury material, consisting probably of the decomposed feldspar. Fragments of cemented sandstone and iron concretions occur on the surface. These soils are developed mainly as small, scattered areas in the sand-hill regions along the junction of the Coastal Plain and the Piedmont. The topography is marked by low, rounded hills and smooth, winding ridges. The timber growth consists principally of longleaf pine and scrub oak. These soils are rather low in agricultural value. Some of the heavier types give good results with cotton, corn, peanuts, and forage crops.

Area and distribution of the soils of the Hoffman series.

Soil name.	State or area.[1]	Acres-
Hoffman sandy loam	North Carolina 23, 25	13,248
coarse sandy loam	Georgia 2	448
fine sandy loam	do	2,112
Total		15,808

[1] For key to numbers in this column see p. 733.

Houston series.—The soils are black and high in lime, especially the subsoil, which in some of the types consists of white, chalky limestone. The members of the series occur principally in the black calcareous prairie regions of Alabama, Mississippi, and Texas. The soils have been derived from the weathering of calcareous clays, chalk beds, and rotten limestones, all of late Cretaceous age. In some localities remnants of later sandy and gravelly deposits have been mixed with the calcareous material, giving rise to the gravelly and loam members of the series. The soils of the Houston series are very productive. They are devoted chiefly to cotton and corn, but some of them will produce excellent and more profitable crops of alfalfa.

Area and distribution of the soils of the Houston series.

Soil name.	State or area.[1]	Acres.
Houston fine sandy loam	Texas 12	64,512
loam	Mississippi 3; Oklahoma 2; Texas 3, 7, 11, 12, 23, 26, 27, 28, 31	1,962,432
clay loam	Texas 11, 12, 27, 28	1,313,536
clay	Alabama 1, 5, 13, 17, 25, 30, 31, 34; Louisiana 14; Mississippi 3, 8, 10, 12, 14, 15, 16, 17, 20; Texas 2, 9, 10, 11, 26, 28, 31.	891,624
stony clay	Texas 9	78,336
gravelly clay	Texas 2, 3, 26, 31	94,720
black clay	Alabama 34; Oklahoma 2; Texas 1, 2, 3, 7, 9, 11, 14, 17, 18, 23, 26, 28, 31, 32.	1,509,080
Undifferentiated	Texas 28	396,288
Total		6,310,528

[1] For key to numbers in this column see p. 733.

Hyde series.—The soils are characterized by their high content of powdery, thoroughly decomposed vegetable matter and by their black color throughout the 3-foot soil section. This color distinguishes them from the Portsmouth soils, which have gray to mottled gray and yellow subsoils. The members are developed in flat or slightly depressed, poorly drained situations. Where properly drained, grains, strawberries, and such vegetables as onions, cabbage, and celery can be grown.

Area and distribution of the soils of the Hyde series.

Soil name.	State or area.[1]	Acres.
Hyde sand	Georgia 10	768
fine sand	Georgia 3, 10	6,720
very fine sandy loam	Georgia 3; North Carolina 16	25,984
loam	Georgia 3, 10	5,824
silt loam	North Carolina 16	8,000
clay	Georgia 3, 10	5,376
Total		52,672

[1] For key to numbers in this column see p. 733.

Karnes series.—This series embraces a group of soils found along certain rivers in Texas, such as the San Antonio and Cibolo. The soils are usually gray or brown in color, though in the lower situations in the valleys they are somewhat darker and grade into the Victoria soils. In texture they range from sand to clay, the sandy soils predominating. They occur as high terraces along the streams lying some 60 feet above low-water mark in the rivers. The soils are derived from Pleistocene terrace deposits, which were formed during a subsidence of the country, causing a partial filling of the stream valleys. While the material was doubtless deposited by streams, the soils probably should be considered as sedimentary rather than alluvial, as they are quite distinct from the soils of the present river flood plains. Small areas are under irrigation and give good yields of onions and alfalfa. Corn and cotton also do well.

Area and distribution of the soil of the Karnes series.

Soil name.	State or area.[1]	Acres.
Karnes undifferentiated	Texas 12	55,296

[1] For key to number in this column see p. 733.

Lacasine series.—The surface soils are dark brown to black. The subsoils consist of a mottled blue and yellow silty clay. Lime and iron concretions are plentiful in the subsoil. These soils are developed as low, flat, poorly drained swampy areas, practically free from sand mounds, and as strips along water-courses and around lakes in southwestern Louisiana. They are formed of reworked loessial material. Cultivation is somewhat difficult, but the soils can be made to produce profitable yields of rice.

Area and distribution of the soil of the Lacasine series.

Soil name.	State or area.[1]	Acres.
Lacasine clay loam	Louisiana 8	3,470

[1] For key to number in this column see p. 733.

Lake Charles series.—The soils of this series are gray to black in color, with mottled yellow and red subsoils, carrying lime and iron concretions. The surface is marked by low, sandy mounds or hummocks. The subsoil is quite resistant to the movements of moisture, and drainage is poorly established, particularly in the depressions, so that crops suffer in wet years. The sand-mound areas are inclined to be droughty. The soils are best suited to sugar cane and grass. Vegetables would probably do well on the better drained areas of the sandy mounds. Some rice is grown where the mounds are not too high or numerous to prevent irrigation. The series occurs on both prairie and tree-covered areas and consists mainly of reworked loessial material.

Area and distribution of the soils of the Lake Charles series.

Soil name.	State or area.[1]	Acres.
Lake Charles fine sandy loam	Louisiana 1, 5, 8	143,924
loam	Louisiana 1, 8	6,378
Total		150,302

[1] For key to numbers in this column see p. 733.

Lamar series.—The Lamar soils are brown to yellowish in color, with lighter colored calcareous subsoils carrying fragments of limestone and lime concretions. The substratum consists of highly calcareous, marl-like material. Erosion gullies are of frequent occurrence. On account of the rough surface and the tendency to erode, little of this land has been cultivated, the members being used merely for pasturage and forestry.

Area and distribution of the soil of the Lamar series.

Soil name.	State or area.[1]	Acres.
Lamar loam	Texas 7	5,696

[1] For key to number in this column see p. 733.

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Landry series.—The surface soils are prevailingly brown in color. The subsoils are grayish and friable and carry both lime and iron concretions. The topography is mainly undulating, the surface inequalities often preventing the successful production of rice. Most of the types are well drained, and are found as prairies. The material is derived from reworked deposits or loess. Rice is grown in favorably situated areas, but cotton and corn are the principal crops.

Area and distribution of the soil of the Landry series.

Soil name.	State or area.[1]	Acres.
Landry silt loam	Louisiana 1	37,696

[1] For key to number in this column see p. 733.

Lauderdale series.—This series is marked by the yellowish to nearly white color of the soils and the abundance of rock fragments found on the surface and throughout the soil section. These consist of soft siliceous rock of a white to mottled yellow, reddish, and gray color, of reddish, locally cemented sandstone, and of hard siliceous rock resembling quartzite. The soil is derived from the Claiborne-Tallahatta Buhrstone formation, which has been subjected to excessive erosion. The topography comprises narrow, high, winding ridges, sharp hills, and steep slopes, and is so rough and stony as to give these soils a very low agricultural value.

Area and distribution of the soil of the Lauderdale series.

Soil name.	State or area.[1]	Acres.
Lauderdale stony clay	Mississippi 9	23,488

[1] For key to number in this column see p. 733.

Leon series.—This series comprises the loose, light-gray to white sandy soils of the South Atlantic and East Gulf coast flatwoods region, which in their typical development have a subsurface "hardpan" stratum, encountered usually at a depth of 12 to 24 inches. This stratum averages from 8 to 10 inches in thickness and consists of a compact layer of fine sand or sand ranging in color from black to dark rusty brown in the upper 2 or 3 inches to rusty brown or slightly darker in the lower portion. It becomes less compact and lighter in color as the lower part of the stratum is approached, a white sand being frequently encountered underlying the stratum and within the 3-foot section. The material of this layer runs high in organic matter and very low in iron, and although the rusty brown color would suggest cementation with iron the analyses indicate that the compactness is due to the presence of organic matter. In places the stratum lies sufficiently near the surface to be plowed up, under which condition it is claimed that crops give very poor results. The substratum is lacking in some phases.

Area and distribution of the soils of the Leon series.

Soil name.	State or area.[1]	Acres.
Leon sand	Florida 6; Georgia 3, 10	66,368
coarse sand	Georgia 10	256
fine sand	Florida 4, 5, 6; Georgia 10	55,360
Total		121,984

[1] For key to numbers in this column see p. 733.

Leonardtown series.—The soils of this series are gray to pale yellow in color. The subsoils are mottled gray, yellow, and red, and ordinarily carry clay lenses and pockets of sand. These soils occupy gently rolling to rolling country in the Chesapeake Bay region of the Coastal Plain, where the Glacial-Piedmont-Appalachian material has been deposited. They are best suited to the general farm crops.

Area and distribution of the soil of the Leonardtown series.

Soil name.	State or area.[1]	Acres.
Leonardtown loam	Maryland 2, 8, 9; Virginia 6, 12	196,514

[1] For key to numbers in this column see p. 733.

Lomalto series.—This series has grayish brown to dark brown soils, and gray, compact clay loam or clay subsoils with a high content of water-soluble salts. The soils are confined to the Gulf Coastal Plains of southwest Texas. The parent material consists of unconsolidated marine sediments, apparently representing an intermediate stage in weathering between the Victoria soils and the deposits which are now being laid down in the flats along the coast. The surface is typically flat, and a large part of the area is marshy. Under the present salty and marshy condition these lands are not generally best suited to pasturage.

Area and distribution of the soils of the Lomalto series.

Soil name.	State or area.[1]	Acres.
Lomalto fine sandy loam	Texas 12, 27	82,944
loam	do	66,816
clay	do	525,824
Total		675,584

[1] For key to numbers in this column see p. 733.

Lufkin series.—The surface soils are light-gray, and underlain by impervious, plastic, and gray to mottled gray and yellow subsoils. The difference in texture between the surface soil and subsoil in the case of the sandy members is very marked. The topography is prevailingly flat, and this, together with the impervious subsoils, renders surface and underdrainage poor, water often standing for long periods after heavy rains. These soils are locally known as "flatwoods land" and "dead lands." Their agricultural value is considerably below that of the Norfolk soils. The timber growth consists largely of scrubby oak and post oak.

Area and distribution of the soils of the Lufkin series.

Soil name.	State or area.[1]	Acres.
Lufkin sand	Texas 17	63,936
fine sand	Texas 3, 10, 14, 19, 24	230,400
sandy loam	Texas 3, 17	362,944
gravelly sandy loam	Texas 12	89,856
fine sandy loam	Mississippi 3, 14; Texas 3, 7, 10, 18, 24, 29	274,176
loam	Texas 18	5,376
gravelly loam	Texas 3, 18	58,112
silt loam	Mississippi 3, 12, 15, 16; Texas 10	72,832
clay	Alabama 34; Louisiana 3, 12; Mississippi 3, 4, 12, 14, 15, 16; Texas 1, 7, 13, 14, 19, 21, 23, 24, 34.	392,256
undifferentiated	Texas 12	357,120
Total		1,907,008

[1] For key to numbers in this column see p. 733.

Mattamuskeet series.—The soils consist of slightly reworked sedimentary materials occupying shallow lakes of the low, flat portion of the Atlantic Coastal Plain. They are characterized by a high content of fine and very fine sand and silt and by unusual textural and structural uniformity throughout the soil profile of 3 feet. Some of the types have a surface layer of mucky material, while in others it is a bluish silty clay. The color ranges from dark gray to black. These soils must be reclaimed by drainage operations before they can be used for agriculture.

Area and distribution of the soils of the Mattamuskeet series.

Soil name.	State or area.[1]	Acres.
Mattamuskeet fine sand	North Carolina 16	3,584
fine sandy loam	do	11,584
very fine sandy loam	do	35,072
silt loam	do	704
Total		50,944

[1] For key to number in this column see p. 733.

Maverick series.—The soils are light gray to brownish in color, and the subsoils yellowish brown to drab and of heavier texture. This soil may be said to represent the western extension of the Houston soils into a region whose arid climate has been less favorable to the accumulation of humus, with the result that the soils are considerably lighter in color. There is also some resemblance to the Zapata soils, the main point of difference being the more level topography. The series owes its origin to the mixing of the weathered underlying limestone and sandstone with the later Pleistocene deposit of calcareous clays.

Area and distribution of the soils of the Maverick series.

Soil name.	State or area.[1]	Acres.
Maverick loam	Texas 28	175,104
clay loam	do	898,560
Total		1,073,664

[1] For key to number in this column see p. 733.

Monroe series.—These soils are gray to brown, with mottled yellow and red, friable subsoils, frequently showing mottlings of drab. Iron concretions are encountered in a few localities. The subsoil of the more nearly level areas of the pine flats is usually more mottled than in the case of the typical soil. Such areas are distinguished from the Hammond soils by the growth of blackjack oak and dogwood in addition to the pine. The soils are derived from reworked loessial material. The surface is gently rolling to hilly and drainage is well established. The types retain moisture well and are adapted to the production of corn, oats, and a number of truck crops.

Area and distribution of the soil of the Monroe series.

Soil name.	State or area.[1]	Acres.
Monroe silt loam	Louisiana 12, 13; Mississippi 16	300,992

[1] For key to numbers in this column see p. 733.

Montrose series.—This series, so far as encountered, occurs in the south-central part of Mississippi and extends into Alabama. The surface soils are gray and are underlain by heavy, plastic yellow subsoils. The soils are derived from a deposit of heavy clay immediately overlying a soft chalky limestone. Areas of these soils are locally known as "flatwoods" or "hog-wallow prairie." The native vegetation consists of a growth of post and scrub oaks and pine.

Area and distribution of the soils of the Montrose series.

Soil name.	State or area.[1]	Acres.
Montrose sandy loam	Mississippi 8	20,928
clay	do	43,840
Total		64,768

[1] For key to number in this column see p. 733.

Morse series.—The surface soils are gray. The subsoils are mottled red and yellow, or red, yellow, and gray, and contain lime concretions. These soils are developed along the slopes of stream valleys where the topography is rolling or broken and the drainage is good. They owe their origin to the exposure of clayey material underlying the Crowley and Acadia soils, which are found closely associated with this series. These soils are not important agriculturally, although they are used for the production of corn and cotton, and in a few of the more nearly level areas for rice. Areas having a pronounced red subsoil are considered more productive than those where the subsoil is yellow. The timber growth consists of pin oak, hickory, and pine.

Area and distribution of the soil of the Morse series.

Soil name.	State or area.[1]	Acres.
Morse clay	Arkansas 4; Louisiana 1	7,424

[1] For key to numbers in this column see p. 733.

Norfolk series.—The Norfolk soils are characterized by the light gray to grayish-yellow color of the surface soils, and by the yellow color and friable structure of the subsoils. They occupy nearly level to rolling uplands throughout the Atlantic and Gulf Coastal Plains, and have been derived mainly from Piedmont-Appalachian material. The members of this series are variously adapted to early, medium, and late truck crops, and to general farm crops. The sandy members predominate. These soils are usually deficient in organic matter which should be added in liberal quantities in order to retain favorable supplies of moisture.

Area and distribution of the soils of the Norfolk series.

Soil name.	State or area.[1]	Acres.
Norfolk sand	Alabama 2, 5, 9, 12, 13, 18, 24, 25, 29, 30, 32, 34; Delaware 1; Florida 1, 2, 3, 5, 6, 7; Georgia 1, 2, 5, 7, 8, 10, 11, 12, 15, 16, 17, 19; Louisiana 2, 13, 14; Maryland 1, 2, 8, 10; Mississippi 2, 5, 8, 9, 18, 20; New Jersey 3; North Carolina 9, 15, 19, 21, 24; South Carolina 4, 6, 7, 8, 10, 11, 12, 14, 15, 16; Texas 1, 14, 24, 32; Virginia 5.	2,826,638
loamy sand	Alabama 1, 2, 8, 12, 29; Mississippi 18	328,576
gravel	Maryland 2, 6, 8, 9; New Jersey 3; North Carolina 22	70,092
gravelly sand	Alabama 2, 12	42,560
coarse sand	Alabama 24, 25, 29, 32; Florida 7; Georgia 3, 5, 7, 15, 17; Maryland 2, 8, 9; Mississippi 8; New Jersey 1, 3; North Carolina 6, 15, 23, 25; South Carolina 6, 9, 10, 16.	513,730
fine sand	Alabama 2, 5, 9, 12, 13, 30, 31, 32; Florida 1, 4, 5, 6, 7; Georgia 2, 10, 11, 12, 16, 19; Louisiana 3, 9, 12, 14; Maryland 10; Mississippi 2, 7, 18; New Jersey 3; North Carolina 6, 7, 8, 9, 19, 20, 21, 22, 24; South Carolina 4, 7, 10; Texas 1, 3, 6, 10, 13, 14, 15, 18, 20, 24, 28, 29, 33; Virginia 10.	2,014,334
very fine sand	Georgia 3	37,120
sandy loam	Alabama 1, 2, 3, 9, 12, 14, 18, 24, 25, 29, 30, 32, 36; Florida 1, 2, 3, 7; Georgia 1, 2, 5, 11, 15, 16, 17, 19; Mississippi 8; New Jersey 1, 3; North Carolina 7, 9, 15, 19, 21. 22, 23, 24, 25; South Carolina 6, 7, 8, 10, 12, 14, 15, 16; Tennessee 6; Texas 24, 34; Virginia 5, 6, 12.	2,450,706
gravelly sandy loam	Alabama 18, 36	14,336
coarse sandy loam	Alabama 32; Georgia 2, 5; North Carolina 15; South Carolina 9; Virginia 12.	59,328
fine sandy loam	Alabama 1, 2, 5, 9, 13, 17, 18, 22, 25, 29, 30, 32, 34, 37; Florida 1, 2, 5, 6, 7; Georgia 1, 2, 8, 10, 11, 15, 16, 19; Louisiana 2, 3, 5, 14; Mississippi 2, 3, 8, 9, 10, 11, 12, 14, 15, 18, 20; North Carolina 6, 7, 8, 9, 15, 19, 20, 21, 22, 24; South Carolina 4, 6, 7, 8, 10, 12, 14, 16; Texas 1, 6, 10, 13, 14, 19, 20, 21, 24, 29, 32; Virginia 5, 6, 10, 12.	4,682,992
very fine sandy loam	Florida 5; North Carolina 21, 24	41,536
loam	Alabama 2, 37; Florida 1; Mississippi 2, 5, 18; North Carolina 6	194,048
gravelly loam	Alabama 24, 25, 30; Mississippi 4, 6,; Virginia 6	140,736
silt loam	Alabama 22; Mississippi 9, 10, 14; North Carolina 15, 20; South Carolina 7; Virginia 5.	67,840
clay loam	Virginia 12	1,856
Total		13,486,428

[1] For key to numbers in this column see p. 733.

Nueces series.—The soils and subsoils of this series are gray and are underlain by a stratum of stiff, mottled grayish clay. The Nueces series is developed near the southwestern Gulf coast. The soils are derived from wind-blown material, originally from the residual prairies, which has been drifted inland from the coast and deposited as a surface mantle over the older Pleistocene clays. The surface is prevailingly flat, with a few dunes. Drainage is ordinarily good, and the soils are devoted to cotton, truck crops, and pasturage.

Areas and distribution of the soil of the Nueces series.

Soil name.	State or area.[1]	Acres.
Nueces fine sand	Texas 12, 27	2,200,320

[1] For key to numbers in this column see p. 733.

Oktibbeha series.—The Oktibbeha soils are prevailingly dull brown to yellowish brown. The subsoils are composed of yellowish brown to somewhat mottled yellow, gray, and red, rather plastic silty clay. The members are developed in close association with the Houston soils, having been mapped only in the "black prairie belt" of Alabama and Mississippi. They are underlain by the soft, rotten limestone which gives rise to the latter series. The topography is flat to gently sloping. The soils occur at slightly varying elevations throughout the prairie regions. The original timber growth consists mainly of post oak, and the members are locally known as "post-oak land" or "post-oak prairie land." Properly handled they produce good crops of cotton, corn, Johnson grass, lespedeza, bur clover, and a number of other crops.

Area and distribution of the soils of the Oktibbeha series.

Soil name.	State or area.[1]	Acres.
Oktibbeha fine sandy loam	Alabama 17; Mississippi 3, 10, 12, 14, 15	82,944
silt loam	Mississippi 10, 12	23,168
clay loam	Alabama 1; Mississippi 3, 12, 15	48,960
clay	Alabama 17; Mississippi 3, 10, 12, 14, 15, 17	214,464
Total		369,536

[1] For key to numbers in this column see p. 733.

Orangeburg series.—The soils of this series are marked by their gray to reddish-brown color and open structure. The subsoils consist of a friable sandy clay. They are confined to the uplands of the Atlantic and Gulf Coastal Plains, being most extensively developed in a belt extending from southern North Carolina to central Texas. In origin they are commonly ascribed to the Lafayette formation, of Piedmont-Appalachian material. This is a valuable series, the heavier members being admirably adapted to corn, cotton, cowpeas, peanuts, potatoes, and cigar leaf tobacco.

Area and distribution of the soils of the Orangeburg series.

Soil name.	State or area.[1]	Acres.
Orangeburg sand	Alabama 2, 18, 29, 30, 32, 34, 37; Florida 1, 2, 5; Louisiana 14; Mississippi 8, 20; South Carolina 6, 12.	267,328
coarse sand	Alabama 32; Florida 7; Georgia 15; Mississippi 9	27,776
fine sand	Alabama 5, 13; Florida, 7; Georgia, 15; Louisiana 2, 9, 14; Texas 3, 14, 18, 24, 28.	252,352
sandy loam	Alabama 1, 5, 8, 9, 12, 14, 17, 18, 22, 24, 25, 29, 30, 32, 36, 37; Florida 1, 6; Georgia 1, 5, 11, 15, 16, 17; Louisiana 2, 3, 5; Mississippi 5, 8, 9, 11, 16, 20; North Carolina, 15, 23; South Carolina 6, 8, 12, 14, 15, 16; Texas 10, 23, 24, 34.	1,091,232
gravelly sandy loam.	Alabama 3, 12, 14, 17, 18, 36, 37; North Carolina 23; Texas 24	117,632
coarse sandy loam	Florida 7; Georgia 5; South Carolina 12, 16	26,240
fine sandy loam	Alabama 1, 2, 3, 5, 8, 9, 12, 13, 14, 17, 29, 30, 31, 32, 34, 37; Arkansas 3; Florida 2, 5, 6, 7; Georgia 1, 3, 8, 11, 16; Louisiana 2, 3, 5, 9, 12, 13, 14; Mississippi 2, 3, 4, 6, 8, 9, 10, 12, 13, 14, 15, 18, 20; North Carolina 8, 24; Oklahoma 2; South Carolina 7, 10; Texas 1, 3, 13, 14, 15, 18, 19, 21, 23, 24, 28, 33.	3,088,064
Total		4,870,624

[1] For key to numbers in this column see p. 733.

Parkwood series.—The distinguishing feature of the Parkwood series is the gray to white lower subsoil of marl. The soils are grayish to grayish brown in color, with subsoils of grayish brown to grayish yellow sandy clay to heavy clay loam in the upper portion, resting upon beds of marl at a depth of 29 inches. Where drained by open ditches these soils are well suited to the production of corn, oats, forage crops, and possibly cotton.

Area and distribution of the soil of the Parkwood series.

Soil name.	State or area.[1]	Acres.
Parkwood fine sandy loam	Georgia 10	320

[1] For key to number in this column see p. 733.

Pheba series.—These soils are gray to light brown with yellow to light-brown, slightly plastic subsoils, usually mottled with brown and gray, especialy in the lower portion. The various members run relatively high in silt. The surface configuration varies from level to gently rolling, and frequently the surface drainage is poor. The members resemble the Oktibbeha soils in color and structural characteristics but differ in that they do not overlie the Selma chalk formation and are less productive and probably less calcareous. The series occurs in close association with the "yellow loam" formation, especially in the soil portion, which is usually underlain by plastic, heavy clay such as is typically developed in the Midway formation of Mississippi.

Area and distribution of the soils of the Pheba series.

Soil name.	State or area.[1]	Acres.
Pheba fine sandy loam	Mississippi 14	13,696
silt loam	Mississippi 3, 14, 15	47,040
clay	Mississippi 14	35,200
Total		95,936

[1] For key to numbers in this column see p. 733.

Plummer series.—The soils of this series are gray and frequently mottled with dark-brownish colors and underlain at a depth varying from 8 to 20 inches by compact, light-gray material more or less mottled with streaks of brown and yellow. The lower portion of the subsoil usually consists of sandy clay or sticky sandy material, including pockets or layers of yellowish plastic sandy clay. The soils are derived from reworked Piedmont-Appalachian material. They are nearly always in a sticky condition, water frequently standing on the surface after heavy rains. A scattered growth of cypress, pine, and occasionally cabbage palmetto, constitute the principal tree growth. This series is typically developed in the flatwoods region of the South Atlantic and Gulf Coastal Plain.

Area and distribution of the soils of the Plummer series.

Soil name.	State or area.[1]	Acres.
Plummer fine sand	Georgia 10	3,456
sandy loam	do	2,368
coarse sandy loam	Georgia 3	10,816
fine sandy loam	Florida 4; Georgia 10	27,008
Total		43,648

[1] For key to numbers in this column see p. 733.

Point Isabel series.—These are heavy soils ranging from drab to brown in color, with slightly lighter colored subsoils. The soil of the clay members does not bake badly like other heavy associated types of inferior drainage, but a thin baked crust is often formed on the surface giving rise to a light grayish color. These soils are developed as long, narrow ridges, standing at sufficient elevation above adjoining poorly drained flats to insure good and often excessive drainage. They are derived from wind-blown clay. The tree growth consists mainly of Spanish dagger, cactus, and mesquite.

Area and distribution of the soil of the Point Isabel series.

Soil name.	State or area.[1]	Acres.
Point Isabel clay	Texas 5	4,096

[1] For key to number in this column see p. 733.

Portsmouth series.—The soils are dark gray to black, and are high in organic matter. The subsoils are light gray to mottled gray and yellow, and the heavier members are always plastic, though usually carrying a noticeable amount of sand. These soils are developed in flat to slightly depressed, poorly drained situations, and require ditching before they can be used for agriculture. The series is most extensively developed in the flatwoods or the low, seaward portion of the Atlantic Coastal Plain and that portion of the Gulf Coastal Plain lying east of the Mississippi River. Scattered areas are frequently found in the poorly drained depressions of the higher Coastal Plain country. When drained the soils are variously adapted to corn, strawberries, and truck crops, such as cabbage, onions, and celery. Applications of lime are usually decidedly beneficial.

Area and distribution of the soils of the Portsmouth series.

Soil name.	State or area.[1]	Acres.
Portsmouth sand	Alabama 2; Delaware 1; Florida 1, 2; Georgia 1, 2, 10, 15, 17; Maryland 10; North Carolina 7, 8; South Carolina 7; Virginia 10.	177,792
coarse sand	Georgia 3, 10	5,568
fine sand	Florida 3, 4, 5; Georgia 2, 3, 10, 11, 16, 19; North Carolina 6, 19; South Carolina 7, 10.	456,576
sandy loam	Alabama 18, 29; Delaware 1; Florida 3; Georgia 2, 11, 15, 16; Maryland 4, 10; Mississippi 18; North Carolina 7, 9, 15, 21, 22, 24, 25; South Carolina 6, 7, 8, 10, 12, 14, 16; Virginia 10, 12.	884,068
coarse sandy loam	North Carolina 25	8,000
fine sandy loam	Alabama 29; Florida 4, 5; Georgia 2, 10, 11, 16, 19; Mississippi 18; North Carolina 6, 8, 9, 15, 19, 20, 21, 22, 24; South Carolina 4, 6, 7, 10, 12, 16; Virginia 12.	459,684
loam	Alabama 2, 29; Georgia 10; Maryland 4; Mississippi 11, 18; North Carolina 6, 7, 8, 9, 19, 20, 23, 24; South Carolina 10, 15.	163,648
silt loam	North Carolina 6, 20; Virginia 10	181,760
clay loam	Georgia 10; Mississippi 18; North Carolina 25; Virginia 12	22,144
clay	Georgia 10, 15; North Carolina 21; South Carolina 6, 10	52,736
Total		2,411,976

[1] For key to numbers in this column see p. 733.

Ruston series.—The soils are gray to grayish brown, and are underlain by reddish-yellow to yellowish-red or dull red, moderately friable subsoils, prevailingly of sandy clay. The series holds an intermediate place between the Orangeburg and Norfolk soils in the color of its subsoils, and a similar place between the Orangeburg and Norfolk on the one side and the Susquehanna on the other side in point of subsoil structure. Occasionally the lower subsoils are mottled with gray and shades of yellow. The soils are closely associated with the Orangeburg and Susquehanna, although probably derived from practically the same formation as the Orangeburg. In crop adaptation they are practically the same as the Orangeburg, although slightly inferior in point of yield.

Area and distribution of the soils of the Ruston series.

Soil name.	State or area.[1]	Acres.
Ruston sand	Alabama 14; Louisiana 9; Mississippi 5, 9, 20	33,088
loamy sand	Mississippi 5	7,168
sandy loam	Alabama 8, 14, 32, 37; Mississippi 5, 20	310,592
gravelly sandy loam	Alabama 1, 8, 14; Mississippi 5, 20; North Carolina 15	152,512
coarse sandy loam	North Carolina 15	3,392
fine sandy loam	Alabama 8, 17, 22, 27, 37; Louisiana 9; Mississippi 5, 9, 10, 12, 17, 20.	1,010,624
silt loam	Mississippi 9, 10	17,728
Total		1,535,104

[1] For key to numbers in this column see p. 733.

San Antonio series.—The soils of this series are brown to chocolate brown in color and have brownish-red, calcareous subsoils. These soils are developed in the semiarid regions of southern Texas. They are derived from calcareous material of sedimentary origin. Under irrigation they give excellent yields of a number of crops such as cotton, corn, sorghum, vegetables, and alfalfa.

Area and distribution of the soils of the San Antonio series.

Soil name.	State or area.[1]	Acres.
San Antonio silty clay loam	Texas 28	398,592
silty clay	Texas 26	18,048
Total		416,640

[1] For key to numbers in this column see p. 733.

Sassafras series.—These soils are distinguished by their yellowish-brown to brown color and mellow structure. The subsoils are reddish yellow and friable in structure, resting upon coarser material or beds of gravel and sand at depths varying from 2½ to 5 feet. The substratum of gravel makes drainage good. The series is developed along flat marine or estuarine terraces standing from 10 to about 250 feet above sea level. They are confined to the northern part of the Atlantic Coastal Plain, where the glacial material has been added to Piedmont-Appalachian material. This series includes some of the most productive soils of the Atlantic seaboard. Excellent crops of wheat, corn, clover, potatoes, melons, berries, and a number of vegetables are secured under good management.

Area and distribution of the soils of the Sassafras series.

Soil name.	State or area.[1]	Acres.
Sassafras sand	Maryland 1, 3, 4, 5, 6, 9; New Jersey 1; New York 7	337,346
loamy sand	Maryland 1, 4	57,024
fine sand	Maryland 1, 8; New Jersey 3; Pennsylvania 17	78,302
sandy loam	Delaware 1; Maryland 1, 4, 8, 9, 10; Virginia 10	332,410
fine sandy loam	Maryland 1, 2, 4, 8, 9; New Jersey 1	101,676
loam	Maryland 1, 2, 4, 10; New York 7	128,356
gravelly loam	Maryland 1, 4, 6; New Jersey 1, 3; New York 7	164.678
silt loam	Delaware 1; Maryland 1, 2, 3, 4, 5, 6, 8, 9; New Jersey 1, 3; Pennsylvania 6, 17.	518,142
Total		1,717,934

[1] For key to numbers in this column see p.733 .

Scranton series.—These soils are dark gray to black, with yellow friable subsoils. The surface soils have the characteristics of the Portsmouth series, while the subsoils resemble those of the Norfolk series. In the poorer-drained situations grayish mottling is frequently noticeable in the lower portion of the subsoils. The surface configuration is flat and the soils are generally in need of better drainage, such as can generally be secured by ditching. The Scranton soils are most extensively and typically developed in the flatwoods country near the coast of the South Atlantic States, in the low flat lands near the Gulf of Mexico, and to the east of the Mississippi River. When properly drained they are fairly well suited to corn, oats, forage crops, and a number of vegetables.

Area and distribution of the soils of the Scranton series.

Soil name.	State or area.[1]	Acres.
Scranton sand	Georgia 2; South Carolina 10	21,952
loamy sand	Georgia 2	13,120
fine sand	Georgia 3, 10; South Carolina 10	30,912
sandy loam	Mississippi 18	640
fine sandy loam	Alabama 29; Georgia 2; Mississippi 18	64,704
silt loam	Mississippi 18	18,112
Total		149,440

[1] For key to numbers in this column see p. 733.

Sumter series.—The soils of this series are predominantly yellow, and the subsoils are slightly brighter in color and carry large quantities of partially weathered rock fragments and chert from the Vicksburg-Jackson limestone, from which the soils are derived. Many areas are cultivated with difficulty on account of the presence of stones, but when these are removed and the land carefully plowed excellent yields of the general farm crops are secured. Peaches give very good results.

Area and distribution of the soils of the Sumter series.

Soil name.	State or area.[1]	Acres.
Sumter stony sandy loam	Georgia 15	1,984
clay	Mississippi 20	6,016
stony clay	do	2,432
Total		10,432

[1] For key to numbers in this column see p. 733.

Susquehanna series.—The Susquehanna soils are gray to reddish in color and are underlain by mottled red and gray, or red, gray, and yellow, plastic heavy clay subsoils. Red is nearly always the predominating color in the subsoil, the other colors appearing only as mottlings in the lower portion of the soil section. These may vary, often being red, white, drab, yellow, and sometimes purple. These soils are developed most extensively in the higher portion of the Coastal Plain from the vicinity of Chesapeake Bay to central Texas. The heavier members are difficult to handle on account of the intractable subsoil. The agricultural value is much below that of the Orangeburg and Norfolk soils. Cotton probably does best in the southern States. Corn and oats are grown quite extensively, but give low average yields.

Area and distribution of the soils of the Susquehanna series.

Soil name.	State or area.[1]	Acres.
Susquehanna sand	Maryland 1	1,600
gravel	Maryland 3, 5; New York 7; Texas 3, 26	119,266
fine sand	Mississippi 9	1,472
sandy loam	Alabama 32; Maryland 1; Texas 24	28,992
stony sandy loam.	Alabama 32	8,384
gravelly sandy loam.	Alabama 37	11,648
coarse sandy loam.	North Carolina 15	19,136
fine sandy loam.	Alabama 3, 5, 8, 9, 12, 22, 32, 37; Georgia 11, 16; Louisiana 2, 3, 5, 9, 14; Mississippi 8, 9, 12, 14, 20; Texas 2, 3, 6, 7, 9, 10, 11, 13, 14, 20, 24, 26, 29, 31.	1,898,496
loam	Texas 24	3,392
stony loam	Texas 6	1,024
gravelly loam	Alabama 3, 17, 30; Louisiana 9; Maryland 1; North Carolina 22; Texas 6, 20, 29.	191,738
silt loam	Mississippi 5, 9, 15	29,952
clay loam	Louisiana 5, Maryland 1, 8	31,826
clay	Alabama 2, 3, 5, 14, 18, 25, 30, 32; Louisiana 2, 3, 9, 14; Maryland 3, 5, 8; Mississippi 8, 9, 10, 14, 15, 20; Texas 10, 11, 13, 14, 20, 29.	483,882
Total		2,830,808

[1] For key to numbers in this column see p. 733.

Tifton series.—The soils are gray to grayish brown in color, and are underlain by bright yellow, friable sandy clay subsoils. Small iron concretions occur on the surface and throughout the soil section. The presence of these ferruginous pebbles gives rise to the local names of "pimply land" or "pebbly land." The surface configuration varies from flat to gently rolling, and the drainage is always good. These soils are most extensively and typically developed in the central portion of the Coastal Plain region, extending through southern South Carolina across Georgia into Alabama. Agriculturally they are considered very valuable, and are adapted to cotton, sugar cane, corn, cowpeas, velvet beans, oats, rye, sweet potatoes, Irish potatoes, pecans, figs, plums, and a number of vegetables.

Areas and distribution of the soils of the Tifton series.

Soil name.	State or area.[1]	Acres.
Tifton sand	Georgia 2, 15, 17	9,728
sandy loam	Georgia 2, 5, 7, 11, 15, 16, 17	356,928
coarse sandy loam	Georgia 5	320
Total		366,976

[1] For key to numbers in this column see p. 733.

Victoria series.—This series consists of brown to black soils, with gray to whitish, calcareous subsoils derived from Pleistocene deposits of the Gulf Coastal Plains. The members are closely related to the Houston series, the principal difference being the more rolling topography of the latter.

Area and distribution of the soils of the Victoria series.

Soil name.	State or area.[1]	Acres.
Victoria fine sandy loam	Texas 12, 27	1,444,608
loam	Texas 12, 27, 28	647,424
clay	Texas 12, 27, 28	2,128,896
Total		4,220,928

[1] For key to numbers in this column see p. 733.

Webb series.—The soils of this series resemble those of the Duval, but are more calcareous and not generally so red in the subsoil. They are brown to reddish brown, with reddish brown to red subsoils. The series is encountered in semiarid areas of the Coastal Plain of Texas. The soils are formed from deposits probably belonging to the Lafayette formation and may be considered as a calcareous, semiarid equivalent of the Orangeburg. They are cultivated to some extent, both with and without irrigation. Most of the series, however, is covered with a thick growth of mesquite and cactus or with valuable native grasses.

Area and distribution of the soils of the Webb series.

Soil name.	State or area.[1]	Acres.
Webb fine sand	Texas 16	3,136
gravelly sandy loam	do	53,760
fine sandy loam	Texas 16, 27, 28	597,248
silty clay loam	Texas 28	34,560
clay	Texas 27	23,040
Total		711,744

[1] For key to numbers in this column see p. 733.

Wilson series.—The series embraces dark-gray to black soils, with mottled gray and drab to black subsoils, usually of stiff, heavy clay. They are typically developed in the mixed prairie and timbered regions of Texas and apparently hold a position intermediate between the Houston and Lufkin series. They differ from the Crockett series in that red is practically absent. The surface is frequently flat so that water stands after heavy rains. The heavier members dry out and bake quickly. Cotton and corn are the principal crops.

Area and distribution of the soils of the Wilson series.

Soil name.	State or area.[1]	Acres.
Wilson fine sandy loam	Texas 24	4,288
loam	Texas 3, 10, 11, 29	29,056
clay loam	Texas 3, 9, 10, 11, 24, 29	96,768
clay	Texas 11	100,864
Total		230,976

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The deep, medium-textured sandy lands of the Atlantic and Gulf Coastal Plains, of loose, open structure, thorough drainage, and consequent warm nature, constitute the earliest truck soils of the region. Invariably they should be selected for growing vegetables for the earliest markets. The yields on these deep sands are rather light and the keeping quality of the products is often not so good as in the case of crops grown upon some of the associated, finer textured soils, possibly on account of the more rapid growth of the plants and the tendency to ship before the crops have properly matured. A case in point is the very early Irish potatoes which are small and unusually perishable when grown upon the deep sands.

These soils are not adapted to general farming. Notwithstanding this fact they are being used, in some cases profitably, for general farm crops in certain sections. This is particularly true as regards cotton, for which heavy applications of commercial fertilizer are used. These are preeminently early truck soils, and their most economic use lies in the production of high-priced crops for the earliest local and distant markets accessible by rapid transportation. Brier fruits, blackberries and dewberries particularly, also early peaches and plums, can be profitably grown for such purposes.

Heavy yields of any crops on these open-structured soils require liberal additions of barnyard manure or complete commercial fertilizers. Owing to the loose structure, added material capable of going into solution or being finely comminuted by decomposition is rapidly washed out or carried down by percolating water, making the effects of fertilizers and manures much less lasting than on the fine-textured soils. Under ordinary conditions these soils are so irretentive of moisture that crops frequently suffer severely during dry seasons. Where the surface is mulched by the shifting of the sand under the influence of winds they frequently hold moisture surprisingly well.

The light gray and white types of the sand group, such as the Norfolk and Leon sand, consist largely of quartz grains, frequently with less than 1 per cent of other minerals present. This is particularly true of the sands near the eastern Gulf and South Atlantic coasts, where the material appears to have been subjected to long periods of trituration. These characteristics indicate a need of heavy applications of manure. Where the color of the sand is more of a brownish shade and the mineral constitution more complex, as in the case of the Sassafras and Collington sands of the North Atlantic Coastal Plain, better yields are almost invariably secured with the same method of soil management.

The sands comprise a large total area throughout the Coastal Plain, being of considerable importance everywhere except in the regions dominated by the Houston, Victoria, Susquehanna, Acadia, and Crowley soils, as in Central Alabama, northeastern Mississippi, southern Louisiana, southeastern Arkansas, central and west Texas, and the flat Gulf border of Texas. The Norfolk sand is by far the most extensively developed of all the members of the group. It

is confined mainly to the Coastal Plain south of the Potomac River-Chesapeake Bay section. In the North Atlantic division the Sassafras sand dominates; in the flatwoods, the Portsmouth and Leon; and in the Georgia-west Florida-Alabama-Mississippi section the Norfolk, Orangeburg, and Ruston sands are the predominating types outside of the flatwoods and Black Prairie belts. The Norfolk and Lufkin types dominate in the sandy portions of the Texas Gulf Plain.

Collington sand.—The soil is a yellowish to reddish-gray, rather coarse sand from 10 to 20 inches deep. The subsoil consists of a greenish-yellow loamy sand and rests at a depth of 3 feet or more upon a rather stiff, olive sandy loam or sandy clay loam approximating in general characteristics the subsoil of the sandy loam member of the series. Glauconitic sand is found in both soil and subsoil. The underlying clay found at depths ranging from 36 to 40 inches makes the soil fairly retentive of moisture, particularly when liberally supplied with organic matter. The type occurs as nearly flat areas at low elevations. Watermelons, cantaloupes, small fruits, and a number of vegetables do very well.

Durant sand.—The soil varies in depth from 26 to 30 inches and consists of a medium to fine sand, containing only a small proportion of the coarser grades of sand and clay. The surface 6 inches is darkened by slight accumulations of organic matter, but below this the sand is white or yellow in color and lacking in humus. The subsoil to a depth of more than 3 feet consists of a yellow, loamy sand to light sandy loam. The type occupies gently to sharply rolling areas and owes its origin to the weathered product of Silo sandstone. Cotton and corn are the only crops which have been grown upon it. Owing to its light texture yields are light. The most profitable use of the type is for trucking.

Gadsden sand.—This type consists of a dark-gray sand 10 inches deep, underlain by a gray or brownish sand subsoil of lighter texture and extending to a depth of more than 36 inches. The soil is of medium to fine texture and ordinarily carries considerable organic matter. The type occupies gentle slopes or undulations near streams and supports a growth of hardwood forests. Cleared areas are very productive. It is one of the best soils for the Florida wrapper tobacco, but requires careful treatment to maintain yields.

Gainesville sand.—This soil is a gray loamy sand about 8 inches deep, containing much organic matter. The subsoil is a loose, brownish loamy sand, which varies in depth, but is usually underlain at 3 feet by a calcareous clay or by partly weathered limestone. Both soil and subsoil contain limestone fragments. The type occupies high, rolling uplands and is well drained. It retains moisture only fairly well and crops often suffer during droughts. The timber growth consists of mixed forest of pine and hardwoods. One of the principal crops is sea-island cotton, to which the soil seems especially well adapted. Early vegetables can also be grown successfully. The type is generally used for cotton, corn, velvet beans, oats, and peanuts, of which light yields are obtained.

Hyde sand.—The type consists of a black sand 3 feet or more in depth. The surface few inches has a somewhat more loamy character than the lower part owing to the presence of considerable organic matter. With this exception there is little change throughout the 3-foot section. The type occurs in poorly drained situations and usually remains in a permanently saturated condition. Pine, water oak, titi, magnolia, bay, gum, and saw palmetto constitute the principal timber growth. With the establishment of good drainage, cabbage, onions, and corn should do well.

Leon sand.—The soil is a light-gray or white medium sand from 6 to 10 inches deep, occasionally containing sufficient organic matter to give it a dark-gray color in the immediate surface section. The subsoil is a compact medium white sand, usually saturated with water. Frequently a layer of brownish sand containing organic matter is encountered at varying depths below the surface. The type has an almost level surface and is deficient in natural drainage. It supports a timber growth of longleaf pine and an undergrowth of wire grass and dwarf palmetto. Few areas are under cultivation, as extensive and costly drainage operations are required to reclaim the land. Heavy fertilization is necessary for success with any kind of crops.

Lufkin sand.—This type consists of a gray, loose and incoherent medium sand about 12 inches deep, underlain by a gray or yellow sand of practically similar texture, frequently becoming compact in structure. The sand is underlain at a depth of 3 to 5 feet by the same drab and yellow mottled sandy clay that forms the subsoil of the Lufkin sandy loam, the only distinction between the two types being the difference in the depth of sand overlying the clay and the con-

sequent variation in the agricultural value. The soil readily absorbs water, while its location on ridges or in proximity to streams insures adequate drainage. It is rather poor and leachy, and crops usually suffer from lack of moisture. It is well suited to sweet potatoes and under intensive methods, with liberal applications of manure, to other early truck crops. It supports a forest growth of post oak, blackjack oak, and some live oak.

Norfolk sand.—The soil is a gray or yellowish, incoherent coarse to medium sand, underlain by a subsoil of yellow sand, and extending to a depth of 3 feet or more. This is a common type on the low, flat river necks and forelands of the Atlantic and Gulf Plains, along the valley slopes of the streams, and level areas of the uplands. These different positions have a marked influence upon its productiveness, the upland areas giving the lowest yields. The drainage is good and crops mature early. The moisture-retaining capacity is so limited that the general farm crops can not be grown with any great success except upon the lower-lying areas where the water table approaches within a few feet of the surface. Corn yields but 5 to 10 bushels per acre and wheat rarely more than 5 or 6 bushels. It is a good early truck soil, especially for the lighter crops. It is used for small fruits and peaches, although not so well adapted to the latter as some of the other soils of the series. Many watermelons are grown upon this soil in the Southern States. In the Connecticut Valley and in Florida a very fine grade of cigar-wrapper tobacco is produced upon the type. In Maryland it produces a good grade of the Maryland export tobacco and in North Carolina and South Carolina a fine grade of cigarette tobacco, although it is not as well adapted to this particular crop as the Norfolk sandy loam. Heavy applications of complete commercial fertilizers or barnyard manure are necessary for good yields of all crops.

Orangeburg sand.—This type consists of a gray medium-textured sand from 6 to 8 inches deep, resting upon a reddish sand, which in turn is underlain at a depth of three feet or more by a red sandy clay. The soil frequently contains some iron concretions and usually occupies gently rolling areas of good natural drainage. Unless heavily manured yields of corn and cotton are low. Early truck crops, peaches, and wrapper tobacco do well with proper fertilization.

Portsmouth sand.—The soil is a black or dark-gray loamy sand, averaging about 12 inches deep, and usually containing a large amount of organic matter. The subsoil is a gray or mottled drab, white, and yellow sticky sand, underlain at depths ranging from 24 to 48 inches by a compact and rather impervious stratum of sand, frequently resembling a hardpan. Occasionally the subsoil is so saturated with water as to resemble quicksand. This type occurs in slightly depressed and nearly level uplands with poor drainage, frequently representing former lake and swamp areas. Corn is the principal crop grown. The type is adapted to berries, particularly to strawberries, although cabbage, onions, and other heavy or late truck crops do well. It is much later in maturing crops, but when well drained gives larger yields than the other soils of this group on account of its large content of organic matter and correspondingly greater water-holding capacity.

Ruston sand.—The soil of the Ruston sand is a light-gray, loose-textured medium sand, ranging from 6 to 24 inches in depth, and underlain by a dingy yellowish-red loamy sand, becoming heavier with depth and resting upon a sandy clay at 36 inches or more. The origin of this type is obscure, but it is probably derived from the coarser sediments of the Eocene or remnants of the Lafayette mantle. The type occupies high ridges, the rolling topography and natural porosity of the material insuring good natural drainage. The soil is somewhat leachy, and crop yields are apt to decline under present methods of management. It is adapted to cotton and truck.

Scranton sand.—This soil is 8 to 12 inches deep, and is ashy to dark gray at the surface, changing to brown at a depth of 3 or 4 inches. The subsoil consists of a compact, white medium sand, and is usually saturated with water. The surface soil is rich in organic matter. The type occurs as poorly drained flat areas usually near streams or "bays", and requires ditching in order to be brought into cultivation. It occupies an intermediate position between Norfolk and Portsmouth soils. Saw palmetto is a conspicuous growth. Reclaimed areas give rather poor results with cotton but better yields of corn and oats.

Sassafras sand.—The soil consists of a dull-brown coarse to medium sand varying in depth from 5 to 10 inches. The subsoil is a reddish-yellow and sometimes orange-yellow sand which becomes slightly loamy and coarser with depth. The surface varies from flat forelands at nearly sea level to gently rolling and low knolls and ridges on the uplands. The type is a light, well-

drained soil and naturally warm and well adapted to vegetables, especially the early market-garden varieties such as tomatoes, asparagus, and sweet and Irish potatoes. It is excellent land for growing cowpeas for seed. The timber growth consists of shortleaf pine and oak.

Susquehanna sand.—The soil to a depth of 6 to 8 inches consists of a pale reddish-yellow to pink sand of loose, open structure. The subsoil is a light-red or pink mealy sand which becomes sticky and changes in color to grayish, scarlet, and pink, at depths ranging from 20 to 36 inches. Stiff, mottled clay corresponding to the Susquehanna clay is encountered ordinarily at depths between 2 and 5 feet. The type occupies the tops of low hills. It is a better soil than the clay loam of the series, being well adapted to vegetables and peaches.

Tifton sand.—This type consists of a medium to coarse sand about 10 inches in depth, gray at the surface and yellowish below. The subsoil is an ochreous-yellow to reddish-yellow loamy sand of rather open structure. The type generally occupies the higher elevations, and is surrounded by areas of Tifton sandy loam. The material is derived from the Lafayette formation and contains many iron concretions. Only one area has been mapped and but little of it is in cultivation.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Norfolk sand	Alabama 2, 5, 9, 12, 13, 18, 24, 25, 29, 30, 32, 34; Delaware 1; Florida 1, 2, 3, 5, 6, 7, Georgia 1, 2, 5, 7, 8, 10, 11, 12, 15, 16, 17, 19; Louisiana 2, 13, 14; Maryland 1, 2, 8, 10; Mississippi 2, 5, 8, 9, 18, 20; New Jersey 3; North Carolina 9, 15, 19, 21, 24; South Carolina 4, 6, 7, 8, 10, 11, 12, 14, 15, 16; Texas 1, 14, 24, 32; Virginia 5.	2,826,638
Sassafras sand	Maryland 1, 3, 4, 5, 6, 9; New Jersey 1; New York 7	337,346
Orangeburg sand	Alabama 2, 18, 29, 30, 32, 34, 37; Florida 1, 2, 5; Louisiana 14; Mississippi 8, 20; South Carolina 6, 12.	267,328
Portsmouth sand	Alabama 2; Delaware 1; Florida 1, 2; Georgia 1, 2, 10, 15, 17; Maryland 10; North Carolina 7, 8; South Carolina 7; Virginia, 10.	177,792
Leon sand	Florida 6; Georgia 3, 10	66,368
Lufkin sand	Texas 17	63,936
Gadsden sand	Florida 2, 5, 6; Georgia 1	54,784
Ruston sand	Alabama 14; Louisiana 9; Mississippi 5, 9, 20	33,088
Scranton sand	Georgia 2; South Carolina 10	21,952
Tifton sand	Georgia 2, 15, 17	9,728
Gainesville sand	Florida 3	7,744
Durant sand	Oklahoma 2	4,288
Susquehanna sand	Maryland 1	1,600
Collington sand	do	1,216
Hyde sand	Georgia 10	768
Total		3,874,576

[1] For key to numbers in this column see p. 733.

LOAMY SAND PHASE.

The soils of the loamy sand group differ but slightly from the sands, but because of their loamy character they are as a class slightly more productive and more easily maintained in a high state of efficiency. They are more retentive of moisture, are less subject to shifting by the winds, and show a greater complexity in mineralogical composition, which tends to make them more durable. They are, however, more closely related to the sands in agricultural value and physical composition than to the sandy loams, although from a field standpoint they are considered as holding an intermediate position between the sands and sandy loams. They constitute more properly a subdivision of the sand group than a separate group of soils.

The loamy sands are of common occurrence in the North Atlantic division, where the Sassafras loamy sand is a prominent soil. South of this region these soils seem to be developed most extensively in the flat coastal regions, where the organic content is prevalently high, and near the inland borders, where apparently the constituent materials have not suffered so severely from comminution and elutriation. The loamy sands are also of common occurrence along the borders of sandy loams.

The Norfolk and Greenville loamy sands are the most important types of this group so far encountered south of the Chesapeake Bay region. The loamy sand member of the Greenville series is likely to be more extensively encountered than the sand for the reason that one of the important features of this series is the presence of fine particles in the soil which adhere to the coarse grains in such a way as to give the material a loamy character.

Greenville loamy sand.—This type consists of a dark-red or reddish-brown medium to fine loamy sand or light textured sandy loam about 12 inches deep, underlain by a lighter red, slightly sticky sand resembling the soil in texture. The type occupies gently undulating areas, low ridges, and knolls, and is derived from the weathering of the Lafayette deposits. Although well drained, the water-holding capacity of the type makes it a desirable and productive soil, both for general farm and special crops. Yields of cotton range from one-third to one-half bale and of corn from 10 to 20 bushels per acre. The soil is admirably adapted to small fruits and vegetables.

Norfolk loamy sand.—The soil to a depth of 10 inches is a gray or brownish medium sand containing enough silt and clay to give it a loamy texture. The subsoil is a yellowish or brownish sandy loam of nearly the same texture as the soil. The type is derived from an unconsolidated noncalcareous formation of Cretaceous age, from which a layer of Lafayette material has been removed by erosion. The topography is level to undulating, with abrupt escarpments along the streams. The porous subsoil makes the type somewhat droughty.

Ruston loamy sand.—The type consists of a grayish loamy sand about 12 inches deep, becoming yellowish red to dull red in the subsoil. Drainage is thorough to excessive, and crops are likely to suffer during dry seasons. Liberal applications of commercial fertilizers and vegetable manures are necessary to secure ordinary yields.

Sassafras loamy sand.—The soil is a dull-brown loamy sand 6 or 8 inches deep, having a gritty feel due to the presence of coarse sand and fine gravel. The subsoil consists of a pale-yellow loamy sand, which at about 15 inches becomes finer in texture and is frequently compact when dry. At 30 inches it grades into a moderately heavy sandy loam. Below this a loose, coarse sand is often found. The topography is gently rolling, with occasional low mounds and irregular ridges and poorly drained intervening depressions. Drainage is usually good, but crops are liable to suffer for lack of moisture on the ridges. The type is considered a fair soil for general farm crops, but is best adapted to such truck crops as melons, cantaloupes, tomatoes, and sweet potatoes. It is easily cultivated and responds readily to fertilizers.

Scranton loamy sand.—The type consists of a dark-gray to black sand or loamy sand about 10 inches deep which is rich in organic matter and is underlain by a compact, light-yellow material about the same in texture as the soil. This in turn rests at 20 to 30 inches upon a light-yellow sticky sand to sandy clay, sometimes slightly mottled with drab and red. The surface is quite flat and the underdrainage poor, the subsoil often being quite saturated throughout a large part of the year. Ditching is necessary to bring the land into proper condition for cultivation. With moderate fertilization a bale of cotton per acre has been secured. Sea-Island cotton makes a rank growth, but yields are rather light. Corn does quite well, also sugar cane and a number of vegetables.

Area and distribution of the loamy sands.

Soil name.	State or area.[1]	Acres.
Norfolk loamy sand	Alabama 1, 2, 8, 12, 29; Mississippi 18	328,576
Greenville loamy sand	Alabama 9, 12; Florida 7; Georgia 15	161,664
Sassafras loamy sand	Maryland 1, 4	57,024
Scranton loamy sand	Georgia 2	13,120
Ruston loamy sand	Mississippi 5	7,168
Total		567,552

[1] For key to numbers in this column see p. 733.

STONY SAND PHASE.

Guin stony sand.—This type consists of a gray to coarse sand often variously colored in the subsoil portion with yellow, gray, white, and red, the colors being confined to different strata. Ferruginous sandstone and gravel conglomerate are

usually abundant over the surface. The type includes patches too small to map, having a sandy clay subsoil. The surface is marked by narrow ridges, steep slopes, and frequent deep gulches. This soil is practically worthless for agricultural purposes.

Area and distribution of the stony sand.

Soil name.	State or area.[1]	Acres.
Guin stony sand	Mississippi 20	7,232

[1] For key to number in this column see p. 733.

GRAVEL PHASE.

Norfolk gravel.—The soil occurs as hills, narrow bands, or outcrops of gravel consisting of 30 to 60 per cent of rounded, water-worn gravel, with interstitial material varying from sand to sandy loam or loam. The subsoil is usually a gravelly sand or sandy loam, occasionally carrying sufficient clayey material to make it slightly plastic. The type is formed through the denudation of gravel layers deposited as shallow-water sediment, river wash, or delta. It is a poor, unproductive soil, generally occupying slopes, and is best left in forest.

Susquehanna gravel.—This soil to a depth of 6 to 20 inches consists of sand, gravel, and cobblestones intimately mixed together and carrying a noticeable quantity of material of the finer grades. The subsoil is generally a heavy, red or mottled sandy clay. In places beds of gravel occur from 2 to 20 feet below the surface. The type occurs in the vicinity of the junction of bottom lands with uplands and is usually rough and hilly. It represents material reworked by river action in early days. The natural timber growth consists of hardwoods, mostly blackjack oak and post oak, with some pines. It is valued mainly for its timber.

Area and distribution of the gravels.

Soil name.	State or area.[1]	Acres.
Susquehanna gravel	Maryland 3, 5; New York 7; Texas 3, 26	119,266
Norfolk gravel	Maryland 2, 6, 8, 9; New Jersey 3; North Carolina 22	70,092
Total		189,358

[1] For key to numbers in this column see p. 733.

GRAVELLY SAND PHASE.

Norfolk gravelly sand.—The soil consists of dull gray medium sand carrying large quantities of rounded, light-colored quartz pebbles. At a depth of 1 or 2 feet, the material is less weathered and the color ranges from yellowish to brown. Otherwise the subsoil is quite similar to the soil, consisting chiefly of medium and coarse sand, with gravel scattered through it. The type occupies slopes and ridges, and is of little or no agricultural value.

Area and distribution of the gravelly sand.

Soil name.	State or area.[1]	Acres.
Norfolk gravelly sand	Alabama 2, 12	42,560

[1] For key to numbers in this column see p. 733.

79619—13——17

COARSE SAND PHASE.

This is the lightest grade of soil used for truck or early vegetables. It is not well adapted to such crops, as it is too open and porous. To correct this deficiency to a degree that would enable the production of even moderate yields would involve too much expense under present economic conditions. Despite its leachy character the coarse sand is used in some sections for cotton with heavy applications of commercial fertilizers, but this practice seems hardly justifiable in view of its adaptability to other crops.

Greenville coarse sand.—The soil is a brown to reddish-brown coarse loamy sand of a more coherent structure than the lighter colored soils of similar texture, such as the Norfolk and Orangeburg coarse sand. The subsoil averages a little lighter in texture than the soil and is usually a brighter red color. The type is often developed on the lower slopes of those divides on which the heavier members of the Greenville series occur. For such a coarse-textured soil the agricultural value is surprisingly high, due largely to the greater capacity for conserving moisture than in case of less ferruginous, lighter colored, coarse sands. While not well adapted to general farm crops, cotton and oats give fair results. Watermelons, sweet potatoes, and a number of vegetables do particularly well.

Leon coarse sand.—The soil is a light-gray to white, loose sand from 14 to 20 inches deep. The subsoil consists of two distinct sections. The upper hardpan layer is a brownish sand, usually about 8 inches thick, and the lower part is a brownish to nearly white loose sand. This soil is very low in moisture-retaining properties and of little agricultural value.

Norfolk coarse sand.—The soil is a gray, loose, and incoherent coarse sand, 8 inches deep, containing 10 per cent or more of gravel, and underlain by a subsoil of the same material, frequently containing iron crusts. The type occurs as level plains or broken slopes. It is not very productive, although used to some extent for tobacco, peaches, and truck.

Orangeburg coarse sand.—The soil is a slightly loamy, gray to reddish-brown coarse to medium sand from 8 to 15 inches deep and frequently containing quartz pebbles and iron concretions. The subsoil is a lighter colored red sand of similar texture and sometimes slightly sticky in the lower depths. The type occurs as level to rolling country and also as terraces. On account of its open, porous nature crops frequently suffer during seasons of moderate rainfall. It produces from 8 to 15 bushels of corn and one-third of a bale of cotton per acre in favorable seasons. In some sections of the tobacco-producing belt, Florida wrapper and filler tobacco are grown, but for the most part the type is too droughty to make this crop a safe one. The type is well suited to vegetables and small fruits. The timber growth consists of oak, hickory, dogwood, sweet gum, and pine.

Portsmouth coarse sand.—The soil is a dark-gray to black, moderately coarse sand from 6 to 15 inches deep and rich in organic matter. The subsoil consists of a grayish, compact coarse sand usually saturated with water in the lower section. Some small coarse gravel occurs on the surface and throughout the soil section. The surface is flat to slightly depressed and drainage poor. By ditching and subsequent applications of lime the soil can be brought into good condition for growing a number of vegetables, such as lettuce, cabbage, onions, and such crops as oats and corn.

Area and distribution of the coarse sands.

Soil name.	State or area.[1]	Acres.
Norfolk coarse sand	Alabama 24, 25, 29, 32; Florida 7; Georgia 3, 5, 7, 15, 17; Maryland 2, 8, 9; Mississippi 8; New Jersey 1, 3; North Carolina 6, 15, 23 25; South Carolina 6, 9, 10, 16.	513,730
Orangeburg coarse sand	Alabama 32; Florida 7; Georgia 15; Mississippi 9	27,776
Portsmouth coarse sand	Georgia 3, 10	5,568
Greenville coarse sand	Alabama 32	1,408
Leon coarse sand	Georgia 10	256
Total		548,738

[1] For key to numbers in this column see p. 733.

FINE SAND GROUP.

The fine-textured sands of the Atlantic and Gulf Coastal Plains are the best general early truck soils, as distinguished from the soils of coarser texture used for the very earliest truck. On account of the fineness of the soil material they are more retentive of moisture. This feature makes them somewhat later in maturing crops, but is more than offset by the heavier yields and, in some instances, the improvement in the quality for shipping. Vegetables on the fine sands mature about 10 days later than on the associated sands.

The series of this group are without doubt the most valuable early truck soils of the province. In adaptation they include the whole range of vegetable crops. The soils respond readily to intensive cultivation and yields are uniformly good. Differences in geographic position with respect to large bodies of water, which make the climatic conditions more uniform, in topographic features, especially elevation, and in transportation facilities have much to do with the selection of the crops which can be grown, and even with the question whether the soil in any particular locality can at present be profitably used for trucking purposes. Under average conditions general farming can scarcely be conducted with any great degree of profit on soils of this texture. Liberal application of manure or complete commercial fertilizers are necessary to make good yields of all crops, and as with the coarser soils, though to a less degree, the effect of manurial treatment is not lasting. The soils are easy to till and although frequently becoming a little more compact than the medium sands, more trouble is experienced with looseness of structure than from the former cause. One of the greatest needs of the members of this group, with the exception of the dark-colored types such as the Portsmouth fine sand, is the liberal and frequent incorporation of vegetable matter. This can most advantageously be accomplished by plowing under crops like cowpeas, crimson clover, beggarweed, and vetch.

The fine sands occur in close association with the sands and are very nearly as extensive. The Norfolk fine sand is the most important member of the inner division of the Coastal Plain east of the narrow "sandhill" belt bordering the Piedmont between the Potomac River-Chesapeake Bay region and central South Carolina.

The Sassafras fine sand is the most important type of this class in the region north of the Potomac. In the Flatwoods region the Portsmouth and Scranton fine sands are prominent soils, except in southeastern Georgia and Florida, where the Leon fine sand is relatively more important. The Orangeburg and Norfolk are the most important fine sands of the inner division of the Georgia, west Florida, Alabama, Mississippi, and northwestern Louisiana Coastal Plain, while these types with the Lufkin fine sand dominate the corresponding portion of Texas. Very little fine sand occurs in the "black prairie" belts of central Alabama, northeastern Mississippi, central and western Texas, the low Coastal Plain of southern Louisiana and southeastern Arkansas, and the flat Coastal Plain border of Texas.

Bienville fine sand.—This soil to a depth of 8 inches consists of a light yellowish gray medium to fine sand underlain to a depth of 36 inches by orange-colored sand. The type occurs as low ridges in the alluvial bottom lands, but is not subject to overflow. The topography is almost level. Very little of it is cultivated, but it should prove a valuable soil for early truck.

Caddo fine sand.—This type consists of a fine sand or fine sandy loam 18 inches in depth, underlain by 10 inches of loam bearing some silt and sand and grading downward into mottled clay. The subsoil often carries iron concretions. The fine sand phase is a loose, incoherent gray or dark-colored sand derived from the coastal terrace deposits. The fine sandy loam phase is a yellow sand or sandy loam occupying situations near rivers. The type is found in low ridges and pine regions and is adapted to truck and orchard crops.

Durant fine sand.—This soil to a depth of 3 or 4 inches is a light-gray fine sand, underlain at 30 to 36 inches by a reddish-gray or yellowish-gray fine sand. The soil is found in the Woodbine formation, and has been formed largely by wind action. It is still being drifted and is of very little agricultural importance, being naturally unproductive. It is easily cultivated, and is better adapted to truck than to other crops. The topography is gently rolling to rolling, and drainage is good.

Duval fine sand.—The soil to a depth of about 12 inches consists of a fine sandy loam of red to reddish brown color. In the upper 1 or 2 inches it is usually a loose, incoherent, fine sand, but the structure of the soil as a whole is

very compact. The subsoil is quite similar to the soil both in color and texture, though it is usually more loamy in the lower part of the profile, and from about 20 to 36 inches is a very light sandy loam of red to reddish brown color. The type occupies comparatively level or gently rolling upland areas. It is derived mainly from the weathering of underlying fine-grained sandstones. The soil supports a heavy growth of native grasses, and is classed as good pasture land. The native vegetation consists mainly of cactus and mesquite.

Greenville fine sand.—The soil is a brown to reddish-brown loamy fine sand from 18 to 20 inches deep. The subsoil is a red loamy fine sand to fine sandy loam, the red color becoming pronounced below 20 to 30 inches. The type occupies gentle slopes and undulating areas. It is derived from the Lafayette formation. Cotton and corn give fair yields, the latter being the most successful crop. Cowpeas, velvet beans, peanuts, rye, and oats are grown with fair results.

Guin fine sand.—This type consists ordinarily of a grayish, loose, incoherent fine sand about 12 inches in depth. The subsoil is a loamy fine sand of dull brownish color and frequently of great depth. The type is derived from the Tuscaloosa formation of Cretaceous age and occupies high divides at the northern border of the Gulf Coastal Plains. It is associated with areas of Susquehanna gravelly loam. On account of the deep leachy subsoil its agricultural value is low.

Hyde fine sand.—The soil is a black very fine sand from 10 to 14 inches deep and with a high content of organic matter. The subsoil is a black or brownish-black compact very fine to fine sand, also containing a higher proportion of organic matter. The type occurs in poorly drained depressions, frequently as narrow strips, between slight ridges of lighter colored soils. Artificial drainage is required for the production of crops other than rice, to which the type is well suited. With drainage and applications of lime, corn, oats, lettuce, strawberries, onions, and cabbage do well.

Leon fine sand.—The soil is a light-gray to white fine sand, underlain at a depth of 12 inches by a white fine sandy subsoil extending to a depth of 3 feet. A brownish, compact layer of sand is often developed at a depth of 15 to 20 inches. The type has a nearly level surface, and, owing to the wet or swampy condition of some areas, a part is unfit for agriculture. Longleaf pine is the principal tree growth. In origin, topography, and drainage the type is similar to the Leon sand, although it has a much finer texture. The soil is of little use as it now exists, and it is at least doubtful whether, except in local areas, it would be worth while, under present conditions, to improve it. Heavy applications of commercial fertilizer would be necessary to insure good yields of any crops.

Lufkin fine sand.—The soil is a gray fine sand or loamy fine sand, about 10 inches deep, resting upon a subsoil of much the same character but occasionally more loamy. A gray or mottled stratified clay is encountered at depths ranging from 3 to 5 feet. The type is generally well drained, but occasionally small depressions occur where the drainage is deficient. Such areas are locally known as "crawfish land." The natural forest growth is scrub pine and oak. The soil produces fair yields of corn and cotton, but is rather better adapted to early truck crops and peaches. The incorporation of organic matter by means of green manuring crops is necessary if crop yields are to be increased, and liberal additions of manure or complete fertilizer mixtures can also be used with profit.

Mattamuskeet fine sand.—The type consists of a brown or dark-gray fine sand, which is 36 inches or more in depth, and quite uniform throughout the soil profile. A shallow covering of black mucky material is found on the surface in places. When reclaimed the type should prove well suited to the production of vegetables.

Norfolk fine sand.—The soil is light-brown or gray fine sand, about 8 inches deep, loose and incoherent when dry, but packing slightly when wet. The subsoil is of much the same texture, slightly heavier, lighter in color, and somewhat more adhesive. The type occurs as low, rolling hills and level areas, and is generally well drained. It is adapted to nearly the same class of crops as the Norfolk sand, but yields are somewhat higher. It is the best early truck soil of the Coastal Plain, but produces only fair crops of cotton and corn. In Florida a fine grade of wrapper tobacco is grown on this soil.

Nueces fine sand.—The soil consists of a gray, fine, loose, incoherent sand, from 12 to 15 inches deep, often somewhat loamy, and underlain to a depth of 36 inches by a lighter-colored material of similar texture. Below this depth a stiff, slightly mottled grayish clay is usually encountered. The type is of wind-

blown origin, the sand having been drifted inland by the wind and laid down as a surface mantle over the older Tertiary clays. The surface is for the most part comparatively level, though in some small areas dunes occur. Drainage as a rule is excellent. The type is devoted mainly to pasturage, but small areas are being planted to truck crops and cotton.

Orangeburg fine sand.—The soil is a gray to grayish-brown fine sand from 10 to 15 inches deep. The subsoil is a grayish-red to red fine sand to loamy fine sand. The topography ranges from undulating to hilly and ridgy, and drainage is good. The type is easily worked under a wide range of moisture conditions and is largely under cultivation. It is well adapted to peaches, plums, melons, and early vegetables. It is the most productive soil of this group and better adapted to cotton and corn than the other soils. It is not quite so early in maturing vegetables as the Norfolk fine sand, but it is particularly valuable in Texas for the supply of early fruit and vegetables for the western markets. It is one of the best soils for cigar-filler tobacco of the Cuban type of leaf.

Plummer fine sand.—The type consists of a gray to brownish-gray very fine sand to loamy fine sand about 6 inches deep, underlain by sand having about the same texture as the soil, but brownish gray to dingy gray in color. The type occupies depressions and very flat areas having poor drainage. Patches have been ditched and used for corn and sweet potatoes with fair success.

Portsmouth fine sand.—The soil consists of a dark-gray to black fine sand, from 10 to 20 inches deep. The dark color is the result of accumulations of organic matter. With its typical drainage the subsoil is a grayish to nearly white fine sand sometimes resting upon a stratum of varying thickness consisting of reddish-brown, compact fine sand, rich in organic matter. At depths below 3 feet a pure white sand, locally known as quicksand, is usually encountered. This type is of marine sedimentary origin and occupies poorly drained, depressed and level uplands. The natural surface drainage is but imperfectly established, and the water table stands at an average depth of about 2 feet below the surface at all times, while after heavy rains the surface is flooded for days at a time. The natural vegetation is long-leaf pine, with an undergrowth of palmetto and gallberry bushes. Little of the type is in cultivation, but where drainage is established or secured through artificial means it is, with fertilization, a fine soil for late and heavy truck crops, such as celery, onions, potatoes, cabbage, and strawberries. On account of the large amount of organic matter which makes it more retentive of moisture, it is not as early as the other soils of this group, but the yields are generally larger and the quality of the vegetables good.

Sassafras fine sand.—The soil to a depth of 8 to 10 inches consists of a reddish-yellow to light-orange, rather loose medium to fine sand. The subsoil is a reddish-yellow loamy fine sand. The type is inclined to be droughty, but its moisture-holding capacity is more easily improved, through the incorporation of organic matter, than in case of the more open and incoherent fine sands of some other series. It occupies low terraces, ridges, and hilltops. A number of vegetables do well and considerable tobacco is grown.

Scranton fine sand.—The soil is a dark-gray to black fine sand ranging from 8 to 12 inches in depth. The subsoil is a pale yellow to yellow, slightly compact fine sand, sometimes faintly mottled with grayish colors in the lower portion. The poor drainage favored by the level surface configuration has resulted in accumulation of organic matter in the surface portion of the type. This soil holds an intermediate position between the Norfolk fine sand and Portsmouth fine sand. Artificial drainage by means of ditches is necessary in order to bring the type into the best condition for cultivation. The soil is somewhat more productive than the Norfolk fine sand and with a liberal use of commercial fertilizers, corn, cotton, oats, sugar cane, Irish potatoes, peanuts, cowpeas, and a number of vegetables give fair returns. Much of the type is timbered with longleaf pine.

Susquehanna fine sand.—This soil consists of gray, rather loose fine sand about 24 inches deep, grading into pale yellow below the first few inches. The subsoil is a reddish to mottled red and yellow, drab, or gray plastic clay. The type generally occupies the crests of ridges and tops of knolls. Drainage is excessive unless liberal amounts of organic manures, such as barnyard manure or crops like cowpeas and rye plowed under, are supplied frequently enough to maintain a more nearly loam structure. With heavy fertilization fair crops of cotton, corn, and forage are secured. Melons and sweet potatoes and a number of vegetables do well.

Webb fine sand.—The soil to a depth of about 12 inches consists of a red to reddish-brown fine loamy sand, loose and incoherent in the first few inches, but becoming compact below. The subsoil is similar in color and texture to the soil, though it usually becomes more loamy in the lower part of the profile, changing to a very light red to reddish-brown sandy loam at depths ranging from 20 to 36 inches. The soil is derived mainly from the weathering of underlying fine-grained sandstones. It occupies comparatively level to gently rolling upland areas. The type supports a heavy growth of native grasses and is classed as very good pasture land. The native vegetation consists mainly of cactus and mesquite.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Nueces fine sand	Texas 12, 27	2,200,320
Norfolk fine sand	Alabama 2, 5, 9, 12, 13, 30, 31, 32; Florida 1, 4, 5, 6, 7; Georgia 2, 10, 11, 12, 16, 19; Louisiana 3, 9, 12, 14; Maryland 10; Mississippi 2, 7, 18; New Jersey 3; North Carolina 6, 7, 8, 9, 19, 20, 21, 22, 24; South Carolina 4, 7, 10; Texas 1, 3, 6, 10, 13, 14, 15, 18, 20, 24, 28, 29, 33; Virginia 10.	2,014,334
Duval fine sand	Texas 27, 28	709,632
Portsmouth fine sand	Florida 3, 4, 5; Georgia 2, 3, 10, 11, 16, 19; North Carolina 6, 19; South Carolina 7, 10.	456,576
Orangeburg fine sand	Alabama 5, 13; Florida 7; Georgia 15; Louisiana 2, 9, 14; Texas 3, 14, 18, 24, 28.	252,352
Lufkin fine sand	Texas 3, 10, 14, 19, 24	230,400
Sassafras fine sand	Maryland 1, 8; New Jersey 3; Pennsylvania 17	78,302
Leon fine sand	Florida 4, 5, 6; Georgia 10	55,360
Scranton fine sand	Georgia 3, 10; South Carolina 10	30,912
Caddo fine sand	Louisiana 8	13,970
Hyde fine sand	Georgia 3, 10	6,720
Mattamuskeet fine sand	North Carolina 16	3,584
Plummer fine sand	Georgia 10	3,456
Webb fine sand	Texas 16	3,136
Greenville fine sand	Alabama 9	2,432
Guin fine sand	Alabama 3	2,304
Durant fine sand	Texas 11	1,600
Susquehanna fine sand	Mississippi 9	1,472
Bienville fine sand	Texas 9	384
Total		6,067,246

[1] For key to numbers in this column see p. 733.

VERY FINE SAND PHASE.

The very fine sands hold moisture better than the fine sands. They frequently act much like silt loams, yet they are easier to handle in so far as cultivation is concerned. Soils of this phase are of comparatively little importance in the Atlantic and Gulf Coastal Plain. They give good results with sweet potatoes and strawberries and fairly good results with cotton, corn, and forage crops.

Coxville very fine sand.—The soil consists of a very fine sand, grading into a pale yellow very fine sandy loam at a depth of 24 inches. The subsoil is a mottled yellow and red fine sandy clay of somewhat plastic structure. The topography is flat to gently undulating and drainage is good. With liberal applications of high-grade commercial fertilizers and the frequent incorporation of vegetable matter, such crops as cabbage, sweet potatoes, Irish potatoes, tomatoes, beans, cantaloupes, cotton, corn, sugar cane, velvet beans, and cowpeas give good results.

Norfolk very fine sand.—The soil is a gray, loose very fine sand, ranging from about 6 to 12 inches in depth. The subsoil is a gray to pale yellow very fine sand slightly more compact than the soil. The topography is hummocky to slightly ridgy or gently rolling. The soil conserves moisture better than the Norfolk fine sand. With liberal incorporation of vegetable matter and application of commercial fertilizers good results are secured with early truck crops, oats, corn, and forage.

Area and distribution of the very fine sands.

Soil name.	State or area.[1]	Acres.
Norfolk very fine sand	Georgia 3	37,120
Coxville very fine sand	do	3,904
Total		41,024

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

The sandy loam soils constitute the medium early truck and light general farming soils of the Atlantic and Gulf Coastal Plains. They are the lightest desirable soils for general farming, are more retentive of moisture than the fine sands, and mature crops about 10 days later. The keeping quality of some vegetables raised on these soils is better and the yields heavier than with either the fine sands or sands. General farming comes in on the sandy loams, but the yields are rather light except under intensive methods of soil treatment, including the frequent incorporation of vegetable matter and liberal application of manures.

Medium early melons, cucumbers, cabbage, tomatoes, garden peas, beets, lettuce, Irish and sweet potatoes, radishes, string beans, dewberries, and blackberries give good results. Strawberries do fairly well.

In the South Carolina trucking section the well-drained sandy loams mature vegetable crops about the same time as the fine sands of eastern North Carolina, the difference in climate being about two weeks.

Of the general farm crops peanuts, sorghum, cotton, dent corn, cowpeas, velvet beans, and bright tobacco give moderate to good yields, according to the way in which the crops are handled. Oats and rye, and in the North Atlantic division wheat, yield fairly well with liberal applications of manures.

In the fight against the boll weevil cotton growers using the sandy loams have a very decided advantage in the rapidity with which the crop attains maturity. Corn matures earlier, but does not yield so well as on the heavier soils. Wheat and hay, except in the North Atlantic section, do not occupy an important position in the crop system, although they may be produced incidentally in connection with the intensive treatment of the truck fields.

For general farming on this class of soils the lightest equipment in labor, teams, and buildings is required, necessitating a smaller initial outlay of capital, although this condition is counterbalanced by smaller crop returns. Drainage and other conditions are responsible for wide variations between the different types in their use and development and will be more specifically discussed in their individual descriptions.

Heavy applications of complete commercial fertilizers minimize the inherent differences between the agricultural values of the sandy loams and finer textured soils. The extensive Norfolk sandy loam type, for example, which in its natural state yields from one-third to one-half bale of cotton to the acre, is being made to yield from 1 to 2 bales over considerable areas in the Carolinas by using acreage applications of 500 to 2,000 pounds of commercial fertilizer. Since this is being done on a paying basis under present conditions, it is not necessary from the standpoint of profit to advise against the practice of making the soil thus yield so far ahead of its natural capacity. It is well to note, however, that much fertilizing material is lost on such porous land through leaching, and that the practice is somewhat wasteful, regardless of the profits. With a more liberal supply of vegetable matter, such as can be added by plowing under crops like cowpeas, vetch, oats, and rye, less fertilizers would be required for the same yields, and, owing to the increased retentiveness of the soil, the effects would be more lasting.

In the north Atlantic division of the Coastal Plain the Sassafras and Collington are the most important representatives of the sandy loam soils. South of this the Norfolk sandy loam is the dominant type of the division outside of the Flatwoods to about central South Carolina. In southern South Carolina, Georgia, and eastern Alabama the Norfolk, Tifton, and Orangeburg sandy loams are the most important members of the sandy loam group outside of the Flatwoods and lime-sink sections. The Flatwoods sandy loams of importance are

the representatives of the Portsmouth, Coxville. Plummer, and Scranton series. In the lime-sink section of southwest Georgia the Greenville, Orangeburg, and Grady sandy loams are the most extensively developed representatives of this textural class. The extensive sandy loams of western Florida are the Orangeburg, Norfolk, and Portsmouth. In central Florida the Gainesville sandy loam is probably the most commonly encountered type of this texture. Western Alabama and that portion of Mississippi north of the Flatwoods include extensive areas of the Orangeburg, Ruston, Norfolk, and Susquehanna sandy loams. The Susquehanna sandy loam seems to be the most extensive of this class of soils in Texas.

The sandy loams are not important in the "black belts" of Alabama, Mississippi, and Texas, the Coastal Prairies of Texas and Louisiana, and southeastern Arkansas. Taking the Coastal Plain as a whole, however, the sandy loams are probably the most extensive of any group of soils, and one of the most important.

Bladen sandy loam.—The soil is a grayish to grayish-yellow loamy sand to sandy loam, from 6 to 15 inches deep. The subsoil is a mottled yellow and gray, friable sandy clay, grading quickly into a plastic heavy clay somewhat more intensely mottled with yellow and gray. The flat surface and the impervious subsoil render surface and underdrainage somewhat deficient. The type is timbered with shortleaf pine, slash pine, and some longleaf pine. Where properly drained, corn, oats, sugar cane, and grasses could probably be grown with fair to good success.

Bradley sandy loam.—The surface soil is 6 to 14 inches deep and consists of a dark-gray sandy loam, which changes to light gray or yellowish in the lower portion as the content of decayed vegetable matter decreases. The subsoil to a depth of 36 inches consists of a red to yellowish-red stiff clay, often containing mica particles and sand, and becoming more tenacious with depth. The depth and color of the subsoil vary with topography, being shallower and brighter colored over the more rolling and elevated areas. The texture of the sand varies from fine to medium, with some coarse sand and angular and rounded quartz gravel, varying from the size of a pea to several inches in diameter. The gravel is found mainly near or along stream courses, with occasional lenses on knolls or some of the high ridges.

Over some parts of the type the soil is frequently a very heavy sandy loam, and in some local areas almost a loam. This loam is underlain at a depth of 6 to 10 inches by an extremely tenacious red clay, containing very little sand. As the type approaches the Coastal Plain the soil gradually becomes a light, sandy loam, from 12 to 14 inches deep, underlain by a pale-red sandy clay with an increased content of sand. Another phase of this type is found usually at the foot of slopes and sometimes on small level or valley-like areas, where the soil is from 18 to 24 inches deep and of rather coarse texture. The topography varies from rolling to undulating and the phase occurs in irregular and broken areas in the Piedmont region, usually as narrow strips bordering stream courses or on narrow ridges or knolls between streams.

This type is residual in origin, being modified to some extent by an admixture of sedimentary material. The soil is devoted to general farming, the principal crops being corn, oats, and some wheat. Fair yields are obtained.

Chesterfield sandy loam.—The soil is a light-gray sandy loam grading at 4 to 6 inches into a very light sandy loam, slightly yellowish in color and varying in depth from 12 to 24 inches. The slightly darker color of the surface soil is due to the presence of decayed organic matter, which also causes the more loamy texture. The sand varies from medium to fine, with occassionally a high percentage of coarse sand and some gravel. The subsoil, found at depths varying from 12 to 24 inches, varies from a yellow to a bright-yellow or light-orange, stiff, sandy clay. A phase of Chesterfield sandy loam is frequently found along the slopes, where the subsoil has a light-yellow color with irregular white streaks running through it. The surface soil here is usually not so deep and slightly heavier than that of the main type. The Chesterfield sandy loam usually occurs in broad and uniform areas with a topography varying from moderately rolling to level. The exact origin of this type is rather difficult to determine. The surface soil appears to be largely sedimentary, while the subsoil, especially the deeper areas, has been formed from the weathering of the underlying granite, gneiss, and other Piedmont rocks, and in places, arkose sandstone. The soil is usually low in organic matter, and the addition of much material is necessary to secure the most profitable returns. Crop yields vary considerably, depending upon the system of management. Corn, wheat, and

oats are the principal crops grown, although small areas are sometimes devoted to the cultivation of tobacco.

Collington sandy loam.—The soil is a brown, loose, loamy sand, from 9 to 20 inches deep, usually containing considerable coarse sand. The subsoil is a yellow or greenish-yellow, sticky sandy loam or sandy clay. The type is derived from the weathering of green glauconite sand, pure greensand being found at depths of 30 to 40 inches. This soil is very productive and is used for general farming, small fruits and nursery stock, and tobacco.

Coxville sandy loam.—The soil consists of a dark-colored to black, light sandy loam, from 8 to 15 inches deep, rich in organic matter, and resting upon a gray to yellowish, light-textured loam, becoming heavier with depth. The subsoil consists of a mottled gray, yellow, and red, rather tough, plastic sandy clay, which is frequently mottled gray, bluish gray, and bright red in the lower section. The surface is usually flat, and the drainage rather poor. The timber growth consists very largely of longleaf pine, with an undergrowth of gallberry bushes. With proper drainage, corn, cotton, peanuts, cowpeas, sugar cane, velvet beans, and soy beans would do well, especially with moderate applications of commercial fertilizers.

Duval sandy loam.—This type consists of a reddish-brown or chocolate-colored, medium to fine sandy loam, from 8 to 12 inches deep, underlain by red or yellowish-red sandy clay. It is derived from a deposit of red sandy material, possibly of the Lafayette formation. The type is known locally as "red sandy mesquite land." It is a good soil and under proper moisture conditions produces excellent crops of cotton and corn, and a variety of truck crops.

Elkton sandy loam.—The soil is a dark-gray, rather silty sandy loam from 6 to 10 inches deep, becoming lighter with depth. The subsoil varies from a medium heavy sandy loam to a loam and carries considerable silt. It is frequently mottled with red and yellow streaks and the mottling becomes more pronounced in the lower depths with gray, red, yellow, and brown colors. Alternating thin strata of clay and sand are common at 30 inches, below which the sand is always saturated with water. The type occupies flat, depressed, poorly drained areas at heads of small streams. The material is derived from marine deposits which have weathered under poor drainage. The ordinary forest growth consists of sweet and black gums, white oak, and maple. Extensive drainage and liming are necessary to make this type productive. This could be done without any great expense.

Gadsden sandy loam.—The soil is a brown sandy loam from 8 to 14 inches deep, underlain by a grayish-yellow or yellow sand or light sandy loam subsoil 3 feet or more in depth. The sand content varies from medium to coarse. The type occurs on slopes and in depressions, where it represents wash or creep from higher-lying areas. The soil produces good crops of cotton and corn, and in the low-lying areas sugar cane does well. In favorable locations it is adapted to growing Sumatra wrappers under shade.

Glenn sandy loam.—The soil varies from a gray to grayish-brown loamy sand to a light sandy loam about 12 inches deep. The subsoil is a yellow, slightly mottled sandy loam or loam. The sand content increases below 30 inches and occasionally carries water-worn white gravel. The type occupies slopes or ridges and surface drainage is good. The material is derived mainly from a thin layer of Coastal Plain deposit laid down over sandstone which has contributed to some extent to the soil. Sandstone fragments are found on the steep hillsides. The forest growth consists of white, post, and blackjack oaks. Cultivated areas are used for corn and cotton, but yields are uncertain. Potatoes, peanuts, and truck crops should do well. Peaches give good results.

Greenville sandy loam.—The soil consists of a reddish-brown, medium sandy loam about 12 inches deep. The subsoil is a brick-red, sticky sand to sandy loam, becoming heavier with depth. The type occupies level to gently rolling country. On account of its open character it is well drained in the surface section, while the subsoil is fairly retentive of moisture. A moderately rolling, shallow phase is sometimes encountered which consists of a dark-red or reddish-brown, rather heavy sandy loam, about 6 inches deep, underlain by a stiff, light-red sandy clay. When wet this phase is very sticky and is inclined to harden on drying, making cultivation more difficult than with the deeper, lighter phase. The type is of sedimentary origin and derived from the materials of the Lafayette formation. The color of the subsoil is similar to that of the Orangeburg soils. This is an exceptionally good soil and one of the most productive upland types of the Coastal Plain region. Cotton and corn are grown with good results.

Guin sandy loam.—The surface soil consists of a gray or white loamy sand to light sandy loam or fine sand from 15 to 30 inches deep, underlain by a reddish or yellowish sandy clay. Ferruginous gravel and slabby sandstone are common throughout the subsoil. The type occupies steep slopes and narrow valleys, and is excessively drained. It is derived from the weathering and leaching of the Lafayette and Tuscaloosa formations. The best use of this soil is for forestry, as it is not adapted to general farming or trucking.

Harley sandy loam.—The soil consists of a grayish-brown loamy sand to a sandy loam with an average depth of 10 inches. The subsoil to a depth of 3 feet or more is a waxy, tenacious clay varying in color from red to yellow and occasionally drab. Both soil and subsoil contain small quantities of gravel, consisting of quartz and feldspar crystals derived from weathered granite. The type occupies low, rolling hills and slopes of small stream valleys. It is both residual and sedimentary in origin, being derived from the weathering of Tishomingo granites and also from sediments laid down during Cretaceous time. The greater part of the type is forested with oak. Small areas have been cultivated and planted to cotton and corn, both of which give good yields. The soil, however, is best adapted to potatoes, truck crops, and small fruits.

Hoffman sandy loam.—The soil consists of a grayish, loose sand 2 or 3 inches deep, underlain at 6 or 8 inches by a pale yellow or slightly pinkish, incoherent sand to coarse sand. The subsoil is a slightly friable sand to coarse sandy clay of deep pink to red, with mottlings of white, drab, or yellowish. Iron concretions and fragments of ferruginous sandstone are frequently encountered, especially on the surface of small knolls where the sandy surface portion has been partly removed by erosion. The type occurs as slight ridges and knolls and along drainageway slopes in close association with the sand hill phase of the Norfolk sand. It is well drained and forested mainly with scrub oak and a scattering of longleaf pine. Some of the more nearly level areas are used for cotton and corn. Low average yields are secured.

Lufkin sandy loam.—The soil is a gray to brown medium loamy sand or light sandy loam varying in depth from 8 to 20 inches. The subsoil consists of a mottled drab and yellow, tenacious and impervious sandy clay, often streaked with iron stains. Iron and sometimes lime concretions occur in small quantities in both soil and subsoil, and thin beds of gravel are sometimes encountered. The type is derived from the weathering of Gulf Coastal Plain deposits consisting of unconsolidated sands and clays. The topography is flat to rolling. Over the greater part of the type drainage is good. Cotton and corn are the principal crops, while sorghum, Irish potatoes, and truck crops give good results. The timber growth consists largely of post oak, with some blackjack oak and live oak along the streams.

Montrose sandy loam.—The soil consists of a gray sand or sandy loam varying in depth from 4 to 16 inches. The sand is frequently rather coarse and some gravel is commonly present. In places an accumulation of organic matter in the first few inches gives the soil a darker color. The subsoil is a plastic gray and yellow or gray and red mottled sandy clay. The red coloring increases with depth. The topography is generally level, and drainage is frequently inadequate, especially along streams. The type is derived from the Jackson formation of Eocene age. Practically all of the type is timbered with longleaf pine or oak. On the few acres cultivated cotton is the principal product, yields of corn being low. The soil is not adapted to fruits, though vegetables should do fairly well.

Norfolk sandy loam. The type consists of a coarse to medium yellow or gray sand or light sandy loam, 12 to 20 inches deep, resting on a yellow light sandy clay subsoil. It occupies level or gently rolling land and is adapted to sweet and Irish potatoes and other vegetables which reach maturity after those produced on the lighter textured soils. It is one of the best soils for peanuts, and in south Georgia and Florida ranks high for pecans. Fair yields of the Sumatra type of cigar-wrapper tobacco are obtained. In the Carolinas it is exceeded only by the Norfolk fine sandy loam for growing the bright (cigarette) tobacco. It is an ideal soil for early cotton, but is rather light in texture for corn, and under ordinary conditions produces small, early crops. It is used very extensively throughout the South, however, for the production of corn. With moderately heavy fertilization with complete mixtures, especially those high in nitrogen and potash, good crops of corn, cotton, and even oats are secured.

Orangeburg sandy loam.—The type consists of a medium grayish brown to reddish brown sand or light sandy loam, from 4 to 15 inches in depth, resting on a red sandy clay subsoil usually containing small gravel and iron concretions.

It occupies rolling to level upland ridges and slopes and is adapted to general farming, giving good yields of cotton and moderate yields of corn. Truck crops for a medium early market can be successfully grown. In Florida, Alabama, and Texas it is desirable for the Cuban type of cigar-filler tobacco. Peaches give splendid results. Moderate applications of complete commercial fertilizers are necessary to secure best yields.

Plummer sandy loam.—The soil is a grayish loamy sand, faintly mottled with shades of brown, to a depth of about 6 inches, where the texture becomes heavier, the soil finally grading into sandy loam of lighter gray color and mottled with streaks of yellow and brown. The subsoil, beginning at a depth of 20 inches, is a mottled gray, friable sandy clay. The topography is flat and the drainage poor. The type seems to hold an intermediate place between the Bladen and Portsmouth sandy loams. It is probably of estuarine or brackish water (salt marsh) origin. None of this type is under cultivation. With the establishment of proper drainage, corn, oats, forage crops, and sugar cane would probably give fair to good yields, according to treatment and fertilization.

Portsmouth sandy loam.—This type consists of a black, brown, or dark-gray sandy loam soil, about 12 inches deep, frequently containing a very large quantity of organic matter and underlain by a gray or mottled sandy clay, which in turn rests upon a compact sand sometimes approaching a hardpan in structure. The type occupies level or slightly depressed areas in the uplands which are ordinarily poorly drained. Where properly drained this type is adapted to corn, potatoes, and truck crops, particularly strawberries.

Ruston sandy loam.—The soil consists of a gray loamy sand from 6 to 15 inches deep. The subsoil is a fairly friable, yellowish-red sandy clay, the color being intermediate between the red of the Orangeburg and the yellow of the Norfolk. Iron concretions and locally formed ironstone fragments are encountered on the surface and throughout the subsoil. The topography is predominantly rolling, averaging probably rougher than either the Orangeburg or Norfolk. Grayish mottling is sometimes encountered in the lower part of the subsoil. The subsoil is less friable than that of the Orangeburg or Norfolk and more so than that of the Susquehanna. The type has practically the same crop adaptation as the Norfolk, but gives usually somewhat lighter yields. Cotton, corn, peanuts, and forage crops give good results under careful management.

Sassafras sandy loam.—This soil is a light-brown to brown, moderately heavy sandy loam varying in depth from 9 to 12 inches. The subsoil is slightly heavier than the soil and varies in color from reddish yellow to reddish brown, becoming slightly coarser in the lower portion. This type occupies broken stream slopes to moderately rolling and nearly level uplands. The material is formed from the weathering of marine deposits brought down from the region of crystalline rocks to the northward. It is adapted to corn, wheat, tomatoes, and grass. Truck of all kinds can be grown, and also berry and fruit crops suited to the climate. Chestnuts do well.

Scranton sandy loam.—The soil is a dark-gray, medium to coarse loamy sand, 18 to 24 inches deep, underlain by a grayish-yellow sticky sand or sandy clay. The type usually occurs near streams where drainage is good and the topography slightly rolling. The principal tree growth is longleaf and shortleaf pine. It is adapted to the earlier truck crops.

Susquehanna sandy loam.—The surface soil consists of an open-textured gray sandy loam, low in organic matter and varying from 12 to 20 inches in depth. The subsoil is a stiff, red clay, which is somewhat brittle, owing to the presence of coarse and medium sand. In the lower depths mottlings of yellow and gray appear. The type is usually encountered on gentle slopes reaching down to the streams, but may occur at higher elevations on nearly flat or gently rolling uplands. Drainage is good. Post oak and blackjack oak constitute the principal growth. Moderate yields of cotton and corn are produced and early truck should give good results.

Tifton sandy loam.—The type consists of a gray or yellowish-gray medium sandy loam about 10 inches in depth, overlying an ocherous-yellow heavier, more compact, medium sandy loam. Both soil and subsoil contain iron gravel, the type being locally known as "pimply land." The topography is gently undulating to somewhat hilly. Drainage is nearly always good, and the crop yields are considerably higher than those of the associated Norfolk soils. The type is derived from the Lafayette formation and is developed in southwestern Georgia. It will probably be encountered also in the panhandle of Florida and in southern Alabama.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Norfolk sandy loam	Alabama 1, 2, 3, 9, 12, 14, 18, 24, 25, 29, 30, 32, 36; Florida 1, 2, 3, 7; Georgia 1, 2, 5, 11, 15, 16, 17, 19; Mississippi 8; New Jersey 1, 3; North Carolina 7, 9, 15, 19, 21, 22, 23, 24, 25; South Carolina 6, 7, 8, 10, 12, 14, 15, 16; Tennessee 6; Texas 24, 34; Virginia 5, 6, 12.	2,450,706
Orangeburg sandy loam	Alabama 1, 5, 8, 9, 12, 14, 17, 18, 22, 24, 25, 29, 30, 32, 36, 37; Florida 1, 6; Georgia 1, 5, 11, 15, 16, 17; Louisiana 2, 3, 5; Mississippi 5, 8, 9, 11, 16, 20; North Carolina 15, 23; South Carolina 6, 8, 12, 14, 15, 16; Texas 10, 23, 24, 34.	1,091,232
Portsmouth sandy loam	Alabama 18, 29; Delaware 1; Florida 3; Georgia 2, 11, 15, 16; Maryland 4, 10; Mississippi 18; North Carolina 7, 9, 15, 21, 22, 24, 25; South Carolina 6, 7, 8, 10, 12, 14, 16; Virginia 10, 12.	884,068
Lufkin sandy loam	Texas 3, 17	362,944
Tifton sandy loam	Georgia 2, 5, 7, 11, 15, 16, 17	356,928
Sassafras sandy loam	Delaware 1; Maryland 1, 4, 8, 9, 10; Virginia 10	332,410
Ruston sandy loam	Alabama 8, 14, 32, 37; Mississippi 5, 20	310,592
Greenville sandy loam	Alabama 1, 2, 9, 12, 14, 18, 32, 37; Florida 7; Georgia 15; North Carolina 23.	201,664
Collington sandy loam	Maryland 1, 8; New Jersey 1, 3	152,486
Chesterfield sandy loam	Virginia 5	95,680
Bradley sandy loam	Alabama 8; North Carolina 15, 23; Virginia 5	76,992
Glenn sandy loam	Alabama 27	73,600
Guin sandy loam	Alabama 3, 14, 22, 37	34,176
Susquehanna sandy loam	Alabama 32; Maryland 1; Texas 24	28,992
Montrose sandy loam	Mississippi 8	20,928
Coxville sandy loam	South Carolina 10	14,336
Hoffman sandy loam	North Carolina 23, 25	13,248
Elkton sandy loam	Maryland 4	9,280
Harley sandy loam	Oklahoma 2	8,832
Gadsden sandy loam	Florida 5, 6	6,592
Plummer sandy loam	Georgia 10	2,368
Bladen sandy loam	do	2,048
Scranton sandy loam	Mississippi 18	640
Total		6,530,742

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

The stony sandy loams are developed in relatively small areas in sections of the Coastal Plain underlain by limestone, and in large bodies in some of the more rolling portions of the province, particularly in the region where the Susquehanna soils are prominent. The abundance of rock fragments or the rough topography, usually both, makes cultivation either difficult or impossible, and the best utilization of these soils is for pasturage and forestry.

Guin stony sandy loam.—This type differs from the Guin fine sandy loam only in having a rough broken topography and large quantities of iron crust and gravel conglomerate on the surface. It occurs around the heads of streams and on steep, narrow ridges subject to erosion. Only a small portion of it has been cleared of the native growth of oak, hickory, and pine.

Sumter stony sandy loam.—The soil consists of a yellowish-gray to yellow sandy loam from 5 to 12 inches deep, underlain by weathered fragments of limestone and chert, the interstitial material being composed of yellowish sandy clay. The type is derived from the weathering of the Vicksburg-Jackson limestone, fragments of which, with some chert, are found scattered over the surface and throughout the soil mass. The type occurs mainly on ridges and slopes where erosion has exposed the underlying limestone of the region. The cultivated areas give good yields of the general farm crops, although the stone content makes farming somewhat difficult. Peaches do especially well.

Susquehanna stony sandy loam.—The soil is a grayish or grayish-brown medium to coarse sand to sandy loam. The subsoil is usually a stiff, plastic, red or reddish-yellow clay, with but little sand and often mottled with gray. In places the lower portion of the subsoil is a reddish micaceous sand with very little clay. The type is characterized by its rough topography, which includes narrow ridges and low hills rising often above the general level of the surrounding country. Ironstone and ferruginous gravel are scattered over the surface. The type has little agricultural value, except for Bermuda grass.

Area and distribution of the stony sandy loams.

Soil name.	State or area.[1]	Acres.
Guin stony sandy loam	Alabama 22, 27; Mississippi 9, 14	127,808
Susquehanna stony sandy loam	Alabama 32	8,384
Sumter stony sandy loam	Georgia 15	1,984
Total		138,176

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loams are developed most extensively in sections of rolling or dissected topography on slopes and on ridges, where the uneven surface configuration militates against tillage operations. Over the smoother areas the abundance of gravel distinguishes this soil from the ordinary sandy loam. Usually the gravel content is sufficient to influence cultivation, although in many instances the agricultural value of the smoother areas is not very different from that of the corresponding sandy loam types. This is especially true in the case of the more nearly level areas of the Greenville and Orangeburg gravelly sandy loams. In some cases the presence of gravel is even considered an advantage, in that the gravel serves to check erosion.

Bradley gravelly sandy loam.—The soil is a grayish to light-brown or slightly reddish sandy loam, carrying from 25 to 50 per cent of rounded gravel and stones. The subsoil is usually a red brittle clay similar to that of the Cecil sandy loam, although in some areas the color is yellowish. The soil represents a mantle of sedimentary material (Norfolk) over Piedmont material. The type is developed on slopes, knolls, and ridges. It is well suited to cotton, corn, oats, and cowpeas.

Chesterfield gravelly sandy loam.—This type to a depth of 6 inches consists of a dark-gray or brownish-gray gravelly sandy loam, grading into a gravelly loam in situations where the sand content is low. Below this surface soil, and extending to a depth of 10 to 12 inches, is a lighter colored material of practically the same texture, although lower in organic matter and not quite so loamy. The subsoil to a depth of 36 inches consists of a yellowish gravelly clay. Over most of the type the high gravel content makes boring difficult. The type is generally found near stream courses, although it sometimes occurs as narrow strips or ridges in the interstream areas. The topography is rolling and broken, and the majority of the slopes are sufficiently steep to prohibit cultivation. For this reason any estimate of crop yields is impracticable. The timber growth consists principally of hardwood, such as white oak, post oak, hickory, and a scattering of pine.

Collington gravelly sandy loam.—The soil is a grayish-brown to reddish-brown medium sand to light sandy loam from 10 to 15 inches deep. The subsoil is a greenish-yellow to reddish-yellow sandy loam or sandy clay. Quartz gravel, ironstone fragments, and glauconitic sand are conspicuous throughout the soil mass. The type occupies steep and badly eroded areas. The rough topography makes cultivation rather difficult, a fact which, coupled with the open structure of the type, makes it rather undesirable for agriculture.

Goliad gravelly sandy loam.—The surface soil of this type is a dark medium to fine sandy loam from 8 to 10 inches deep, with a variable content of smooth water-worn gravel. There is considerable range in texture throughout the type. The subsoil is a reddish gravelly clay which at various depths, sometimes less than 3 feet, is underlain by the characteristic calcareous material. The topography is rolling to moderately hilly. Most of the type is utilized for pasture, but where cultivated fair yields of cotton, corn, and other crops are secured.

Greenville gravelly sandy loam.—The soil varies from a gray to reddish fine sandy loam with an average depth of 10 inches. The subsoil is usually a bright-red, sandy, gravelly clay continuing to a depth of 3 feet or more, occasionally in the lower part of the section. The surface is usually strewn with small concretions of argillaceous and arenaceous material, which gives rise to the term "gravelly land." This gravel is also found in both soil and subsoil, and upon the hills large pieces of sandstone and iron crusts sometimes occur. The type is found on rolling and hilly areas and has excellent drainage. It

is derived from the weathering of the Lower Claiborne formation of Eocene age. It is a good general-farming soil and also well adapted to peaches, small fruits, and truck crops. It has been used to produce a fine grade of tobacco for home use.

Guin gravelly sandy loam.—The soil consists of a light-brown or gray sandy loam from 8 to 10 inches deep. The subsoil is about the same in texture and is usually yellow or gray. Both soil and subsoil contain a large quantity of water-worn gravel. The surface is rather broken and erosion and drought are likely to result from excessive drainage. The type is derived from the gravel beds of the Lafayette formation. The forest growth consists of oak. Under cultivation the humus is rapidly depleted and yields of cotton are generally low.

Lufkin gravelly sandy loam.—The surface soil consists of a gray medium to fine sand or sandy loam from 8 to 10 inches deep, containing small water-worn gravel. The subsoil is a mottled yellow, gray, or drab, and sometimes brown plastic clay. The type has been formed by the weathering of sand and gravel deposits of Tertiary age. The surface is gently rolling to hilly. Most of the type is in forest, but some areas are farmed, and where the gravel is not too abundant the soil is fairly well adapted to cotton, corn, sorghum, and vegetables.

Norfolk gravelly sandy loam.—The soil is a grayish gravelly sandy loam from 10 to 15 inches deep. The sand particles range mainly from coarse to fine. The gravel content in the soil ranges as high as 50 per cent, and varying amounts are strewn over the surface. The subsoil is a yellow sandy clay containing quartz and quartzite gravel. The type occurs on rounded ridges, slopes, and over gently rolling areas usually of small extent. The soil is so open and well drained that crops are liable to suffer severely during droughts. Yields average rather low. Cotton and corn are grown to some extent. Early vegetables could be grown to advantage on areas where the topography permits cultivation.

Orangeburg gravelly sandy loam.—The soil consists of a reddish-brown sandy loam carrying from 15 to 40 per cent of iron concretions and quartz gravel. The depth often varies from a few inches on the upper slopes, where rock fragments are sometimes present, to 20 inches in lower locations. The subsoil is red or dark red in color and is considerably heavier than the soil. The type is found on low hills and ridges and is well drained. It is not desirable for general farming, but offers good opportunities for early vegetables.

Ruston gravelly sandy loam.—This is a gray loamy sand to light sandy loam underlain at a depth of 10 to 15 inches by yellowish-red or dull red friable sandy clay. Rounded gravel consisting of quartz, chert, and iron concretions occur on the surface and throughout the surface soil. The topography is more or less rolling and the drainage rather excessive. The type is of low agricultural value, though a number of crops, such as cotton, corn, and oats, can be grown with moderate success by liberal additions of organic matter and commercial fertilizers.

Susquehanna gravelly sandy loam.—This type consists of a grayish to reddish brown fine sandy loam to sandy loam from 5 to 15 inches deep, underlain by a plastic red clay mottled with gray and yellow at lower depths. Fragments of ferruginous sandstone with some quartz and chert pebbles are present in quantities sufficient to impart a decidedly gravelly character to the soil mass. The topography is rolling to hilly. The soil is of low agricultural value, being best suited to pasturage and forestry.

Webb gravelly sandy loam.—This type consists of a light-brown to reddish-brown fine sandy loam, about 10 inches deep, carrying a large quantity of rounded, waterworn gravel. On the steep hillsides the fine sandy loam is easily eroded and is seldom more than a few inches deep. When this fine material is washed down to the lower levels, the rounded gravel left on the steep slopes frequently covers from 40 to 60 per cent of the surface. The subsoil consists of a brown to reddish-brown very sandy clay. It contains a large percentage of sand, but is sticky and tenacious when wet, and in small areas on some of the steeper slopes where it has become exposed by the erosion of the upper soils, its surface is baked and suncracked and has the general appearance of a more decided clay content. The topography is rolling. The material is derived from recent deposits of sands, clays, and gravels, modified to some extent by disintegration of the underlying sandstone. The type is not well adapted to agricultural purposes. The gravelly texture of the soil and its rolling

topography makes it better adapted to the growing of fruit than to the production of any crops which would require cultivation.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Greenville gravelly sandy loam	Georgia 15; Louisiana 2, 9, 14	225,536
Ruston gravelly sandy loam	Alabama 1, 8, 14; Mississippi 5, 20; North Carolina 15.	152,512
Orangeburg gravelly sandy loam	Alabama 3, 12, 14, 17, 18, 36, 37; North Carolina 23; Texas 24.	117,632
Guin gravelly sandy loam	Alabama 3, 22, 27; Mississippi 10	93,760
Lufkin gravelly sandy loam	Texas 12	89,856
Webb gravelly sandy loam	Texas 16	53,760
Chesterfield gravelly sandy loam	Alabama 14; Virginia 5	52,480
Bradley gravelly sandy loam	Alabama 8, 14; North Carolina 15	23,232
Goliad gravelly sandy loam	Texas 12	16,128
Norfolk gravelly sandy loam	Alabama 18, 36	14,336
Susquehanna gravelly sandy loam	Alabama 37	11,648
Collington gravelly sandy loam	Maryland 1	320
Total		851,200

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loams are quite widely developed throughout that part of the Coastal Plain east of the Mississippi River, where they are ordinarily found in close association with the sandy loams. They are much less extensive than the latter types, except in the narrow "Sandhill" strip bordering the Piedmont and extending from central North Carolina to the vicinity of Auburn, Ala. In this border strip the Norfolk coarse sandy loam is developed in large areas, and, with the Hoffman coarse sandy loam and Norfolk coarse sand, occupies by far the greater part of the Sandhill region. In southwest Georgia and southeast Alabama the Greenville coarse sandy loam is an important soil.

The coarse sandy loams have practically the same crop adaptation as the sandy loams, but give lighter yields and are more difficult to maintain in even a fair state of efficiency, especially where the clay subsoil lies deeper than 10 or 12 inches. For best results these soils require liberal additions of vegetable matter and relatively heavy fertilization.

Berzelia coarse sandy loam.—The soil is a grayish coarse sandy loam, from 8 to 12 inches deep, and contains large quantities of water-rounded gravel. The subsoil is a yellow to nearly white plastic material, having a soapy feel, owing to the presence of mica flakes. The type is developed in bench-like situations and as slopes along streams, usually near their sources. It is considered a very poor agricultural soil.

Bradley coarse sandy loam.—The soil consists of a light, coarse sandy loam, grayish in the immediate surface portion and yellowish below, ranging in depth from 8 to 20 inches. The subsoil is a clay, which becomes heavier and more plastic with depth. Mica flakes often occur in the subsoil, sometimes in sufficient quantities to impart a greasy feel. The color of the subsoil is similar to that of the Appling subsoils, being mottled or streaked with various shades of red and yellow, and occasionally showing drab or gray. Water-rounded pebbles are occasionally seen in the surface section. The soil is of sedimentary origin, representing Coastal Plain material laid down over the residual subsoil. The topography varies from hilly to gently rolling or sloping. With fertilization good yields of cotton, corn, oats, and forage crops are secured.

Coxville coarse sandy loam.—The soil is a grayish, loose coarse sandy loam from 8 to 24 inches in depth. Between the soil and subsoil there is usually a thin stratum of compact material somewhat heavier than the soil portion. The subsoil proper is a mottled yellow, drab, and red, plastic coarse sandy clay. The topography is level to gently undulating. The type is well suited to Irish and sweet potatoes and to cotton, corn, oats, sugar cane, peanuts, strawberries, and forage crops. Fertilizers are needed to secure good average yields.

Greenville coarse sandy loam.—The soil varies from a dull to pronounced reddish-brown coarse loamy sand to a heavy sandy loam, the material becoming finer with depth. The subsoil is a dark reddish brown to dark-red sandy clay

of rather stiff structure and of high capacity for conserving moisture. The topography varies from undulating on interstream divides to sloping along the stream, where the material approaches somewhat the characteristics of the Orangeburg soils. The good drainage, coarse texture of the surface soil, and moisture-conserving capacity make the type a valuable agricultural soil. Much of this land has been in cultivation for 50 years or more and is still producing good yields of cotton, corn, oats, cowpeas, and sorghum. The occasional incorporation of vegetable matter and the use of commercial fertilizers in moderately heavy applications are necessary for best results.

Hoffman coarse loamy sand.—The soil is a gray coarse sand carrying a large content of small gravel. The subsoil is a rather stiff sandy clay mottled with bright red, white, and drab. The type occurs mainly as small knolls. On account of the open, droughty character of the soil it does not hold moisture well and only moderate yields can be expected without heavy applications of fertilizers and the frequent incorporation of organic matter.

Norfolk coarse sandy loam.—The soil to a depth of 8 inches consists of a brown to yellowish coarse sandy loam. The subsoil is a yellow sandy loam extending to a depth of 24 inches, where it rests upon coarse sand and gravel. Both soil and subsoil contain about 25 per cent of small water-worn gravel, chiefly quartz. The topography is level or gently sloping. The areas of this type represent outwash plains of sand and gravel mixed with finer material. Fair crops of corn, grain, grasses, and especially of small fruits are produced in ordinary seasons, but failures occur in years of drought.

Orangeburg coarse sandy loam.—The soil is a dark-brown to reddish-brown, slightly tenacious coarse sand of open structure, about 10 inches deep. The subsoil is lighter colored than the soil and slightly more tenacious owing to its greater clay content. The type is nearly uniform throughout, with almost level topography and excellent underdrainage. The soil material is derived from the Lafayette formation. The type is easily worked and is practically all in cultivation to corn, cotton, and oats. Yields are usually low, and heavy applications of fertilizers are necessary for profitable cultivation.

Plummer coarse sandy loam.—The soil is a grayish or brownish-gray moderately coarse sandy loam, more or less mottled with dingy brown below the surface few inches. The subsoil, beginning at a depth of 18 to 24 inches, is a sticky, somewhat plastic coarse sandy clay mottled with dingy brown and yellowish white or drab. The type occurs in poorly drained, flat situations. Crawfish mounds are of frequent occurrence. When drained and limed fair results can be had with Irish potatoes, cabbage, corn, and oats.

Portsmouth coarse sandy loam.—The soil consists of a black coarse sandy loam, from 8 to 20 inches deep and high in organic matter. The subsoil is a tenacious coarse sandy loam mottled reddish yellow and drab. The type owes its high organic-matter content and mottled subsoil to imperfect drainage conditions, which have favored the accumulation of organic matter and inhibited soil aeration. For its profitable utilization drainage by means of open ditches is necessary. Where thoroughly drained it is an excellent soil for corn, strawberry, cabbage, onion, lettuce, beet, and celery crops. Oats do fairly well.

Ruston coarse sandy loam.—This type consists of a gray to brownish medium to coarse sandy loam, underlain at depths varying from 8 to 18 inches by a reddish-yellow, reddish-brown, or dull red friable sandy clay, with a moderate content of quartz gravel. The topography varies from level to gently rolling, the rolling areas being confined generally to the vicinity of stream heads. It is smoother than the average of the Ruston soils so far mapped and is admirably situated for farming purposes. The type is retentive of moisture, and drainage is well established. This is a very productive soil, producing under good management from one-half bale to 2 bales of cotton, 20 to 75 bushels of corn, and as much as 1,000 pounds of tobacco to the acre.

Susquehanna coarse sandy loam.—The soil of this type is a gray coarse loamy sand to coarse sandy loam, changing to pale yellow at a depth of 8 inches. The subsoil, encountered at depths ranging from 8 to 24 inches, is a silghtly friable brownish or reddish, sandy clay, which quickly passes into dull red or drab-brown, sticky, plastic clay somewhat mottled with gray or yellow. A layer of ferruginous sandstone is commonly found between soil and subsoil. The substratum in places is a very tough, plastic, laminated bluish clay. The type is developed on slopes between the upland levels and the lower stream soils. The agricultural value is rather low.

Tifton coarse sandy loam.—The soil to an average depth of 8 inches is a grayish-brown coarse sandy loam containing a large amount of small iron con-

cretions. The subsoil is a dull yellow, friable sandy clay, more or less mottled in the lower portion with reddish iron oxide stains. The type occupies flat to gently sloping areas. It is well suited to cotton, corn, oats, peanuts, pecans, and forage crops.

Area and distribution of the coarse sandy loams.

Soil name.	State or area.[1]	Acres.
Norfolk coarse sandy loam	Alabama 32; Georgia 2, 5; North Carolina 15; South Carolina 9; Virginia 12.	59,328
Orangeburg coarse sandy loam	Florida 7; Georgia 5; South Carolina 12, 16.	26,240
Susquehanna coarse sandy loam	North Carolina 15	19,136
Coxville coarse sandy loam	Georgia 3	15,552
Plummer coarse sandy loam	do	10,816
Bradley coarse sandy loam	Georgia 5	10,560
Portsmouth coarse sandy loam	North Carolina 25	8,000
Berzelia coarse sandy loam	Georgia 5	3,712
Greenville coarse sandy loam	Alabama 32	3,712
Ruston coarse sandy loam	North Carolina 15	3,392
Hoffman coarse sandy loam	Georgia 2	448
Tifton coarse sandy loam	Georgia 5	320
Total		161,216

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams are adapted to truck crops, to be marketed between the early and late products. The soils give moderately good yields of vegetables having shipping qualities somewhat better than the earlier crops, but not so good as the latter crops. Owing to their ability to retain moisture, fair yields of the general farm crops are secured, and the members of this group are classed as medium-grade general farming soils. In general, crops mature about two weeks later and the yields average higher than on the sandy loams.

Of the vegetables, melons, cucumbers, cabbage, beets, tomatoes, garden peas, lettuce, Irish and sweet potatoes, radishes, string and lima beans, cauliflower, spinach, eggplant, squash, and carrots do particularly well. Strawberries, dewberries, and blackberries give excellent results.

Cotton matures somewhat later than on the sandy loams, but quite early enough to make these soils well suited to growing the crop under boll-weevil conditions. Fair yields of dent corn, sugar cane, rye, and oats, and good yields of peanuts, bright tobacco, cigar-wrapper tobacco, cowpeas, velvet beans, crimson clover, and sorghum are made. The quality of sirup from sugar cane grown on the light-colored fine sandy loams is exceptionally good.

The fine sandy loams are of nearly the same extent and occur in the same general regions as the sandy loams. The Sassafras fine sandy loam seems to be the main representative of this group of soils in the North Atlantic division. The Norfolk fine sandy loam is the most widely distributed and extensive. It is a very important agricultural soil throughout the inner Coastal Plain from central Virginia to central Texas, being in various sections largely used in the production of bright tobacco, cotton, corn, peanuts, cowpeas, melons, cucumbers, cabbage, and other vegetables, sugar cane for sirup, and strawberries. From the neighborhood of the Santee River in South Carolina the Orangeburg fine sandy loam assumes about equal importance with the Norfolk fine sandy loam, both in extent and area under cultivation. It is naturally a somewhat stronger soil than the corresponding Norfolk type. It is used chiefly for cotton, corn, oats, and cowpeas. Vegetables do not succeed so well, nor is the quality of sugar-cane sirup so good as in the case of the Norfolk fine sandy loam.

The most important fine sandy loams of the Flatwoods division belong to the Portsmouth, Coxville, Scranton, and Plummer series.

Exclusive of the prairie belt of Alabama and Mississippi, the inner division of the Coastal Plain embraces large areas of Ruston, Susquehanna, Orangeburg, and Norfolk fine sandy loams. The Coastal Prairie division of Texas and Louisiana includes important developments of fine sandy loams of the Victoria and Lake Charles series. In eastern Texas, northwestern Louisiana, and south-

ern Arkansas the Caddo, Susquehanna, and Lufkin fine sandy loams comprise the most extensive areas of this class of soil. The Webb and Wilson fine sandy loams are the most important so far mapped in central and west Texas.

Beeville fine sandy loam.—The type consists of a gray fine sandy loam, from 10 to 20 inches deep, overlying gray stratified clay, sometimes mottled with yellow. It occupies higher terraces along the streams and probably represents an extension of deposits of Pleistocene age from the level coast country up the smaller stream valleys. Where transportation facilities are convenient truck crops are profitably grown. The soil also produces fair yields of corn and cotton.

Bienville fine sandy loam.—The soil consists of a gray or light-brown fine sandy loam about 8 inches deep and grades into a light-brown or reddish-brown, sticky fine sandy loam at depths ranging from 15 to 24 inches. It represents sandy depositions along the edge of extensive swamps or at the junction of large streams when great volumes of water were flowing from the northward. These areas are locally known as " hammock " land. They lie above high water, and the gently rolling surface insures good drainage. The type is easy to cultivate and is well adapted to general farming and trucking.

Bladen fine sandy loam.—The soil is a grayish to pale yellow loamy fine sand to light fine sandy loam, from 8 to 15 inches deep. The subsoil is a fine sandy clay which quickly grades into heavy clay, or the heavy clay may directly underlie the surface soil. The subsoil is plastic and sticky, and is mottled yellow and gray in color. Lime concretions are sometimes encountered in the lower section. The topography is level to gently undulating, and surface drainage is poor. Gum and cypress ponds of small area occur throughout the type. In origin the type seems to hold an intermediate place between the Salt marsh and Coxville fine sandy loam. With the advancement of weathering it is believed the soil will assume the characteristics of the Coxville fine sandy loam. Very little of the type has been cultivated. Some good yields of corn, sweet potatoes, and sugar cane have been secured in years of normal seasonal conditions. Drainage will be necessary to bring the type into proper condition for cultivation.

Boeuf fine sandy loam.—The surface soil is a brown, loamy fine sand 8 inches deep, underlain by a plastic heavy sandy clay. The line of demarcation between soil and subsoil is well established. At 30 inches the subsoil becomes lighter in texture, frequently approaching a sandy loam. The type is found on small ridges 15 to 30 feet above the surrounding flat, alluvial lands and probably represents remnants of the Lafayette formation where the overlying loess has been largely removed. It is a very productive type. Cultivated areas produce from 30 to 40 bushels of corn and nearly a bale of cotton to the acre.

Brennan fine sandy loam.—The surface soil consists of a gray to light-brown, heavy fine sandy loam, about 12 inches deep. The subsoil is a brown, fine sandy loam, becoming heavier with depth, and containing enough silt and clay in the lower part of the 3-foot section to make it plastic and sticky when wet and to give it the characteristics of a fine sandy clay. The lower portion of the subsoil is hard and compact and is usually so dry that it can be crushed into a fine powder, but when wet it becomes stiff and plastic, and the content of silt and clay is very noticeable. The type is level to gently undulating in topography and is formed mainly from the weathering of an old deposit of fine sands and sandy clays of sedimentary origin, modified to some extent by wash from the rolling uplands. Only a very limited acreage is under cultivation. During favorable seasons fair yields of cowpeas, corn, and sorghum have been obtained. The greater part of the type is valued as pasture land and supports a heavy growth of native grasses.

Caddo fine sandy loam.—The soil consists mainly of sand of the finer grades, with a mixture of gray, brown, or yellow silt, and varies in depth from 8 to 30 inches, depending upon the number of sand mounds on the surface. The intermound areas are usually dark brown and the hillocks lighter colored. The subsoil over the more level areas is heavier in texture and composed of gray or mottled red and yellow silt and clay, quite impervious to water and in places approaching the structure of hardpan. Over areas where the sand mounds are more prevalent it is usually lighter and more nearly like the surface soil. Iron concretions are sometimes found in the surface 8 to 10 inches of soil. The sandy material of the upper part of the sand mounds is usually leachy, the silty material collecting around the base and forming an almost impervious

subsoil. This material resembles the Norfolk fine sandy loam, the main points of difference being in the topography and in the color of the subsoil.

The type occupies rather depressed situations, with level to gently rolling topography. It not infrequently marks the flat, swampy areas out of which streams flow and is also found in the low, flat areas skirting lakes. The type is derived from beds of sandy clays belonging to the Port Huron group, which represent old lake beds or swampy lands that are just beginning to develop drainage channels. The soil is suited to crops requiring a moist soil, and it is probable that sugar cane, rice, and certain varieties of truck, such as strawberries and cabbage, would do well. Except where the sand mounds are so numerous as to interfere with flooding rice can be grown on this soil, the greater part of it being better adapted to this crop than any other. Corn and cotton are the principal crops for which the type is now used.

Coxville fine sandy loam.—The soil consists of a gray to dark-gray moderately heavy fine sandy loam, varying in depth from 6 to 20 inches, with an average depth of 10 inches. The subsoil is a stiff, rather plastic clay, which ranges in color from yellow in the upper part to mottled yellow, drab, and bright red in the lower section. Small iron concretions and quartz gravel are sometimes encountered in both soil and subsoil. The topography is generally undulating to flat. Where thoroughly drained by open ditches the type is well suited to cotton, sweet potatoes, and the Klondike strawberry. It is not as good for early truck as the corresponding member of the Norfolk series, although better for cotton and strawberries. Lime is needed to improve the structure.

Crockett fine sandy loam.—The soil is a dark-brown to nearly black fine sandy loam or heavy fine sandy loam, varying in depth from 6 to 12 inches. The subsoil is a loam which grades into a stiff clay loam, generally mottled with red or yellow and often carrying concretions of iron gravel. It is found as gently rolling prairie land with occasional gravelly hillocks. Drainage is good. This soil is particularly adapted to oats and corn.

Durant fine sandy loam.—The soil is a heavy fine sandy loam, from 14 to 18 inches deep. It has a characteristic chocolate-brown color that is uniform throughout the type. The subsoil is usually mottled yellow and brown and in the heavier phase grades downward into a clay loam. The type occupies rolling prairies. The material is derived from the weathered product of the Bokchito formation of Cretaceous age. Cotton, corn, and oats are the principal crops grown and give fair yields.

Duval fine sandy loam.—The soil is usually a reddish-brown fine sandy loam, from 6 to 12 inches deep. The surface few inches of material is very sandy and might be classed as a loamy fine sand, the lighter texture being due to the removal of the fine particles by wind. The subsoil is a light sandy clay of practically the same color as the soil except where the former has been darkened by accumulations of organic matter. Limestone and occasionally sandstone are encountered at depths ranging from a few inches to 4 or 5 feet and outcrops are of frequent occurrence. The origin of this soil is very similar to that of the Duval fine sand and it simply represents areas where a larger amount of fine material is present. The topography varies from gently undulating to rolling and hilly. The type supports a heavy growth of scrubby chaparral, guajillo, and numerous varieties of thorny bushes and cactus. The amount of mesquite is small, especially where the rock is near the surface. Very little of the type has been cultivated. Its agricultural value depends largely upon the depth to the underlying limestone, the soil over a large proportion of the area being scarcely deep enough to justify its use for general agriculture. Areas of deeper soil, where moisture conditions are favorable, are very productive and well suited to cotton, truck, fruits, and grapes. Peaches should prove successful on this type under irrigation.

Edna fine sandy loam.—This type consists of a gray fine sandy loam or loamy fine sand, from 8 to 20 inches deep. The subsoil to a depth of 36 inches or more consists of mottled gray and yellow impervious clay. There is a very distinct line of demarcation between the soil and subsoil. Small sand mounds are characteristic surface features. The type is sedimentary in origin, having been formed from noncalcareous deposits laid down in shallow Gulf waters during Pleistocene times. The topography is almost level, with gently undulating and slightly rolling areas near the streams. The type is devoid of timber except for small strips near the drainageways. It is not a very strong soil, but under proper treatment gives fair yields of cotton, corn, and other general farm crops. It is well adapted to the production of truck, and some areas are being utilized for this purpose.

Elkton fine sandy loam.—The soil consists of a heavy, dark-gray, medium to fine sandy loam, about 10 inches deep, frequently containing a rather high percentage of silt and having a slightly sticky feel. Below this, to a depth of 15 to 20 inches, is a very light-yellow fine sandy loam, sometimes almost white, and not quite so heavy as the surface soil. The subsoil is a mottled gray or bluish sandy clay, varying occasionally in texture and frequently showing a yellowish or drab color spotted or streaked with iron stains. It is a wet and poorly drained soil and little of it is under cultivation. A system of drainage must be established before agriculture can be made successful. Under good conditions only fair yields are obtained.

Goliad fine sandy loam.—The soil consists of a dark-gray to black fine sandy loam, from 8 to 20 inches deep, underlain by red to reddish-brown sandy clay or clay loam. At depths ranging from 2 to 6 feet, a soft, white calcareous material is encountered, which is sometimes exposed on the steep slopes. The topography is gently rolling and drainage is good. Owing to the ease of cultivation, its water-holding capacity, and its natural productiveness, the type is well adapted to truck and other hand-cultivated crops.

Grady fine sandy loam.—The type consists of a dark-colored fine sandy loam from 8 to 15 inches deep, resting upon a mottled drab, yellow, and red, tenacious, impervious clay, which contains varying amounts of the finer grades of sand. It occupies sink-hole depressions and nearly level to flat, poorly drained country, slightly elevated above the stream channels or swampy flood plain which it borders. Small flat areas in the uplands occur as saucer-like depressions and require artificial drainage. The surface soil is composed of reworked upland material in which a large amount of organic matter has been incorporated. The subsoil is derived from or influenced by the underlying limestone which may be encountered within the 3-foot section. Sinks, depressions, and underground stream channels are formed by the weathering of the limestone and are characteristic features in some localities. The type in some localities is known as "hammock land" and is recognized as a productive soil. It produces good yields of sugar cane and corn in favorable seasons. The timber growth consists of oaks, beech, gum, magnolia, and scattering pine.

Greenville fine sandy loam.—The soil is a red, medium to fine textured sandy loam, ranging in depth from 4 to 15 inches. The subsoil to a depth of several feet is a bright red sandy clay. The type occupies level, plateau-like stretches in close proximity to streams, and is well drained. It is derived from the weathering of Lafayette clays. The native forest growth consists of pine, red and white oaks, post oak, and hickory. Cotton and corn are the chief crops grown, and the yields are good. The soil is also well adapted to fruits and early truck crops. Irish potatoes, radishes, and onions are grown and give large returns. The type should also produce a high grade of Cuban leaf tobacco.

Hoffman fine sandy loam.—The soil consists of a light-gray to yellowish fine sand to loamy fine sand, from 12 to 15 inches deep. The subsoil is a rather stiff, plastic sandy clay conspicuously mottled with purplish and pinkish red, gray, and yellow. Pebbles and fragments of iron-cemented sandstone occur throughout the soil section. The topography is somewhat broken, being usually rougher than that of the Norfolk fine sandy loam. The type is generally considered poor, although with careful handling much of it gives fairly good results with cotton, corn, peanuts, sweet potatoes, cowpeas, and velvet beans.

Houston fine sandy loam.—This type consists of 8 to 12 inches of dark gray, brown, or black fine sandy loam underlain to a depth of 36 inches by dark gray to brown heavy sandy loam to clay loam. Often at 18 to 24 inches a stratum of white, calcareous material is encountered and this sometimes outcrops in small spots on the slopes and tops of the hills. This type is derived from sandy calcareous formations. The surface is moderately rolling to very rolling and hilly. It was originally prairie, although an occasional mesquite and huisache tree is found. The soil is quite fertile and produces from one-fourth to 1 bale of cotton per acre, 20 to 40 bushels of corn, and good yields of sorghum and other general farm crops. It is well adapted to truck crops, especially cabbage, onions, tomatoes, and potatoes.

Lake Charles fine sandy loam.—The soil is a dark-brown or black or sometimes light-gray, heavy very fine sandy loam, 14 inches in depth. The subsoil is a loam which grades at 10 inches into a clay loam containing some silt, which in turn is underlain by a mottled clay, often carrying iron or lime concretions. The type is found on the higher elevations and is marked by sand hummocks. It owes its texture to local erosion and admixture of sand from

hummock areas, and was originally a coastal deposit. It is adapted to crops requiring light soils and medium drainage.

Lomalto fine sandy loam.—The type consists of grayish-brown to dark-brown loamy fine sand to fine sandy loam from 10 to 12 inches deep, underlain by a heavy fine sandy loam or loam which grades into a gray clay at a depth of 2 or 3 feet. The soil has been formed by the incorporation of organic matter with the sandy material deposited over the gray clays. The topography is level to slightly undulating. The characteristic vegetation is the sacahuistle grass, although a scattering growth of mesquite is found upon areas adjoining the Victoria fine sandy loam. None of the type is under cultivation and unless freed from alkali salts it is doubtful whether crops would prove successful. It is now used for pasture and under present conditions is best devoted to this purpose.

Lufkin fine sandy loam.—This soil type consists of a gray or brown fine loamy sand or light sandy loam about 12 inches in depth, resting on a mottled gray and yellow, plastic, impervious sandy clay subsoil. The surface is level to rolling and drainage is well established. The type is derived from Coastal Plain deposits. The timber growth is chiefly scrub oak. Cotton and corn are the principal crops.

Mattamuskeet fine sandy loam.—The soil consists of a brown or black fine sandy loam varying in depth from 10 to 20 inches. The subsoil is a gray or brown very fine sand. When wet the soil is decidedly mucky, but upon drying out it has the appearance of fine sandy loam, with a high organic-matter content. When reclaimed this soil should be well suited to crops like cabbage, celery, potatoes, onions, and corn.

Norfolk fine sandy loam.—The surface soil consists of a pale-yellow or gray fine sandy loam 6 to 8 inches deep, and is underlain by a yellow fine sandy loam, which grades into a light sandy clay at an average depth of 18 inches. The type occupies level plains and rolling uplands and is generally well drained. It gives moderate yields of corn, and is well adapted to late truck crops, and in parts of the South to cotton and to bright yellow tobacco. This soil is not as valuable for early truck as the Norfolk fine sand, but makes a good medium to late truck soil. In North Carolina it is considered a better tobacco soil than the Norfolk sandy loam, and fully equal, if not superior, to the Norfolk fine sand.

Oktibbeha fine sandy loam.—This type consists of 5 to 10 inches of brownish-gray to light-brown fine sandy loam, grading directly into a rather heavy, yellowish-brown sandy clay, which becomes mottled at depths varying from 2 to 3 feet. Numerous phases occur as a result of erosion and difference in drainage conditions. The topography is rolling, and except for local seepage drainage is good. It is derived from the sandy clay known as the Yellow Loam formation The original forest growth consists largely of oats, hickory, and maple. The type is largely under cultivation to cotton and corn, but its agricultural value is lessened by severe erosion. Peaches, pears, and plums do well.

Orangeburg fine sandy loam.—The soil consists of a gray to brown fine sand or light fine sandy loam from 4 to 15 inches deep, underlain by a red sandy clay. The type occupies level and rolling to hilly areas in uplands and has good drainage. It is well adapted to cotton, gives fair yields of corn, and is particularly well adapted to truck crops, peaches, and, in Texas, to Cuban filler tobacco. It is the principal peach soil of the Fort Valley area, Georgia.

Parkwood fine sandy loam.—This soil is a gray to grayish-brown loamy fine sand, 6 to 8 inches deep. The subsoil consists of a light sandy clay to heavy clay loam of a grayish-brown to grayish-yellow color, grading at a depth of 20 inches into a grayish or white marl. Drainage is often poor owing to the flat surface. Where open ditches have been established, good crops of corn and oats have been grown. The type is considered good for general farming.

Pheba fine sandy loam.—The surface soil is a gray to light-brown fine sandy loam from 6 to 10 inches deep. The subsoil is a yellowish-brown, heavy fine sandy loam, which gradually grades into a fine sandy clay or silty clay. The lower subsoil is usually mottled with reddish-yellow and gray colors. A heavy clay substratum is encountered at 3 to 6 feet. The surface configuration is flat to gently rolling or undulating. Ditching is necessary on some of the more level areas. The type is deficient in organic matter and for best results requires the occasional plowing under of such crops as cowpeas and rye. Cotton, corn, peanuts, oats, rye, cowpeas, soy beans, and sorghum give good results under proper soil management.

Plummer fine sandy loam.—The soil is a gray, loamy fine sand sometimes faintly mottled with brown. At 8 to 18 inches a compact loamy fine sand of

gray color or gray mottled with streaks of brown or yellow is encountered. Below this is a mottled gray or yellow fine sandy clay or sticky fine sand, including pockets or layers of yellowish plastic fine sandy clay. As a rule the type is poorly drained on account of its flat surface and low position. Cypress, pine, and cabbage palmetto constitute the main timber growth. The soil is typically developed in the flatwoods country of the Coastal Plains. Very little of it has been utilized for agriculture, but with the establishment of good drainage oats, corn, and sugar cane would probably give good results if fertilized. A number of vegetables, such as onions, lettuce, and cabbage, could also be grown profitably.

Portsmouth fine sandy loam.—The soil to an average depth of 12 inches is a black or rusty brown, mucky fine sandy loam, compact and heavy when wet. Large quantities of organic matter in all stages of decomposition are usually present. Under continued cultivation the soil becomes lighter in both color and texture and the sand content more pronounced. The subsoil is usually a mottled drab and yellow, massive and sticky, sandy clay, with a depth of more than 36 inches, and is underlain occasionally by a layer of very fine white or gray sand. Where the type occurs within sand areas the subsoil often consists entirely of sand. The surface is level or slightly depressed. The type owes its existence and its peculiar characteristics to poor drainage. In some cases artificial drainage is impracticable owing to the level surface. The type supports a heavy growth of cypress, gum, magnolia, and other water-loving trees and undergrowth. When cleared and properly drained Irish potatoes and cabbages are successfully grown, especially the latter. Cotton and corn give fair yields in favorable situations. The type is well adapted to onions and some of the berry fruits.

Ruston fine sandy loam.—The soil of this type is a light-gray or yellowish-gray fine sandy loam of variable depth, but averaging about 20 inches. The subsoil is a buff or reddish yellow, somewhat mottled heavy fine sandy loam or sandy clay. The subsoil is not so red as that of the Orangeburg fine sandy loam, but more so than the Norfolk fine sandy loam. The type occupies broad, high divides and long, gentle slopes reaching to stream bottoms. The topography varies from nearly level to gently rolling, and the drainage, while usually good, is sometimes deficient. The soil is inclined to be droughty and crop yields diminish under the usual methods of management. The type is derived from unconsolidated sediments of the Eocene period, modified by an admixture of Lafayette material. The natural forest growth consists of oak and shortleaf pine.

Sassafras fine sandy loam.—The surface 2 or 3 inches is light brown in color, but grades gradually into a pale-yellow material which extends to a depth varying from 12 to 20 inches. The soil has the texture of a silty fine sandy loam and is underlain by a reddish light silty loam. The type is found largely on lower flat lands along the water front where drainage is poor. It also occurs upon higher, moderately rolling areas with better drainage. It is derived from the weathering of marine deposits. Native trees consist mainly of pine, white oak, chestnut, and sweet and black gum. A portion of the type is devoted to general farming, including such crops as wheat, corn, grass, and tomatoes. Poorly drained areas could be made productive by drainage and without prohibitive outlay of money.

Scranton fine sandy loam.—The soil consists of a dark-gray, fine sandy loam from 8 to 10 inches deep, passing abruptly into a yellow or yellowish-gray fine sandy loam, becoming heavier with depth. There is usually little or no mottling in the subsoil. The type occurs as relatively broad areas of flat to gently undulating topography, often occupying gentle slopes between the Norfolk and Portsmouth series. Drainage is better than that of the Portsmouth fine sandy loam and not so good as the Norfolk fine sandy loam. The forest growth consists of long-leaf and short-leaf pine. The type is adapted to practically the same crops as the Norfolk fine sandy loam, but on account of the higher content of organic matter is a stronger soil.

Susquehanna fine sandy loam.—The soil is a gray to brown fine sand or light fine sandy loam about 12 inches deep, resting upon a red or yellowish-red clay, which is usually stiff and plastic and mottled in the lower depths. Iron concretions are found throughout the soil profile. The type has been derived principally from the underlying clays. The surface is generally rolling or hilly, and erosion is sometimes quite pronounced. The soil is adapted to fruits and vegetables. Potatoes and peaches do exceptionally well. Cotton and corn give medium yields.

Victoria fine sandy loam.—The soil consists of a light-brown to gray fine sandy loam from 12 to 15 inches deep and is underlain by a lighter colored sandy clay which is often mottled with iron stains. This extends to a depth of 36 inches, and in the lower depths carries thin local deposits of lime. The type occurs principally as hills and bluffs adjacent to the ancient coast line of Nueces Bay. The surface varies from nearly level to quite rolling and the drainage is excellent. The surface material is of aeolian origin, having been blown from the old coast line and deposited as a surface mantle over the older calcareous clays of Tertiary age. With heavy fertilization it is an excellent soil for such early truck crops as onions and cabbage. Melons, tomatoes, lettuce, and sweet potatoes also do well. Such general farm crops as cotton and corn produce fair yields.

Webb fine sandy loam.—The soil to an average depth of 10 or 12 inches is a light-brown to reddish-brown fine sandy loam. Rounded gravel is sometimes found scattered over the surface or mixed with the soil, although the type as a whole is generally free from gravel or rock fragments and is very uniform in texture and color. The subsoil consists of a brown to reddish-brown very sandy clay. The upper part contains a considerable amount of fine sand and closely resembles a very heavy, sticky, sandy loam. This becomes heavier with depth, and at 18 to 20 inches grades into a compact sandy clay, sticky and tenacious when wet, but still containing a large percentage of medium and fine sand. The type occupies level to gently rolling areas and is of sedimentary origin, formed from the reworking of older Coastal Plain deposits. Small areas have been put under irrigation. The soil is productive and where irrigated produces good yields. The irrigated land is used mainly for growing onions and seems well adapted to this crop. Sweet potatoes, cabbage, turnips, and beets have been grown to a very limited extent on such lands. Cowpeas do well on both the unirrigated and irrigated areas. Corn and sorghum give fair yields on unirrigated areas during favorable seasons. A good quality of tobacco leaf has been produced on this soil.

Wilson fine sandy loam.—The soil is a dark-gray to nearly black fine sandy loam varying in depth from 7 to 15 inches. The subsoil is a dark-colored clay loam which is very stiff and compact at lower depths. The type occurs as high prairie land and also as second-bottom flats adjacent to streams such as the Brazos River. Drainage is good and the type more or less subject to drought during June and July. If water is allowed to stand after rains, the soil becomes crusted and hard to manage. The native growth is largely mesquite. Practically all of the type is in cultivation to cotton and corn. Fair yields of both are obtained, although corn is liable to suffer from drought.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Norfolk fine sandy loam	Alabama 1, 2, 5, 9, 13, 17, 18, 22, 25, 29, 30, 32, 34, 37; Florida 1, 2, 5, 6, 7; Georgia 1, 2, 8, 10, 11, 15, 16, 19; Louisiana 2, 3, 5, 14; Mississippi 2, 3, 8, 9, 10, 11, 12, 14, 15, 18, 20; North Carolina 6, 7, 8, 9, 15, 19, 20, 21, 22, 24; South Carolina 4, 6, 7, 8, 10, 12, 14, 16; Texas 1, 6, 10, 13, 14, 19, 20, 21, 24, 29, 32; Virginia 5, 6, 10, 12.	4,682,992
Orangeburg fine sandy loam	Alabama 1, 2, 3, 5, 8, 9, 12, 13, 14, 17, 29, 30, 31, 32, 34, 37; Arkansas 3; Florida 2, 5, 6, 7; Georgia 1, 3, 8, 11, 16; Louisiana 2, 3, 5, 9, 12, 13, 14; Mississippi 2, 3, 4, 6, 8, 9, 10, 12, 13, 14, 15, 18, 20; North Carolina 8, 24; Oklahoma 2; South Carolina 7, 10; Texas 1, 3, 13, 14, 15, 18, 19, 21, 23, 24, 28.	3,088,064
Duval fine sandy loam	Texas 27, 28	2,240,960
Susquehanna fine sandy loam	Alabama 3, 5, 8, 9, 12, 22, 32, 37; Georgia 11, 16; Louisiana 2, 3, 5, 9, 14; Mississippi 8, 9, 12, 14, 20; Texas 2, 3, 6, 7, 9, 10, 11, 13, 14, 20, 24, 26, 29, 31.	1,898,496
Victoria fine sandy loam	Texas 12, 27	1,444,608
Edna fine sandy loam	Texas 12	1,248,768
Brennan fine sandy loam	Texas 27	1,108,224
Ruston fine sandy loam	Alabama 8, 17, 22, 27, 37; Louisiana 9; Mississippi 5, 9, 10, 12, 17, 20.	1,010,624
Webb fine sandy loam	Texas 16, 27, 28	597,248
Portsmouth fine sandy loam	Alabama 29; Florida 4, 5; Georgia 2, 10, 11, 16, 19; Mississippi 18; North Carolina 6, 8, 9, 15, 19, 20, 21, 22, 24; South Carolina 4, 6, 7, 10, 12, 16; Virginia 12.	459,684
Lufkin fine sandy loam	Mississippi 3, 14; Texas 3, 7, 10, 18, 24, 29	274,176
Goliad fine sandy loam	Texas 28	172,800
Caddo fine sandy loam	Louisiana 3, 8, 9, 14; Texas 6, 10, 13, 29	172,028
Coxville fine sandy loam	South Carolina 7, 10	150,784

[1] For key to numbers in this column see p. 733.

Area and distribution of the fine sandy loams—Continued.

Soil name.	State or area.	Acres.
Lake Charles fine sandy loam..	Louisiana 1, 5, 8	143,924
Beeville fine sandy loam	Texas 12, 28	117,504
Sassafras fine sandy loam	Maryland 1, 2, 4, 8, 9; New Jersey 1	101,676
Durant fine sandy loam	Oklahoma 2; Texas 9, 11	89,856
Lomato fine sandy loam	Texas 12, 27	82,944
Oktibbeha fine sandy loam	Alabama 17; Mississippi 3, 10, 12, 14, 15	82,944
Scranton fine sandy loam	Alabama 29; Georgia 2; Mississippi 18	64,704
Houston fine sandy loam	Texas 12	64,512
Greenville fine sandy loam	Alabama 1, 3, 5, 37; Georgia 8; Louisiana 9	60,544
Plummer fine sandy loam	Florida 4; Georgia 10	27,008
Elkton fine sandy loam	Virginia 5	14,656
Bladen fine sandy loam	Georgia 10	14,592
Pheba fine sandy loam	Mississippi 14	13,696
Mattamuskeet fine sandy loam	North Carolina 16	11,584
Bienville fine sandy loam	Louisiana 2, 9	6,336
Crockett fine sandy loam	Texas 24	4,416
Wilson fine sandy loam	....do	4,288
Hoffman fine sandy loam	Georgia 2	2,112
Grady fine sandy loam	Florida 7	1,536
Boeuf fine sandy loam	Louisiana 6	320
Parkwood fine sandy loam	Georgia 10	320
Total		19,458,928

VERY FINE SANDY LOAM PHASE.

The very fine sandy loams more properly constitute a phase of the fine sandy loams than a distinct soil group. These soils grade from fine sandy loams toward silt loams in such a way that it is frequently difficult to establish the boundaries. In fact, this can only be done by the most careful examinations under field conditions.

The typical very fine sandy loams are, under similar conditions of drainage, a little more productive than the fine sandy loams of the same series and are somewhat more easily worked and maintained in mellow tilth than the silt loams.

The very fine sandy loams comprise a relatively small area as compared with the fine sandy loams.

Bladen very fine sandy loam.—The soil is a grayish very fine sandy loam averaging 10 inches deep. The subsoil is a grayish very fine sandy clay which at about 18 to 24 inches grades into a plastic, mottled yellow and red heavy clay. The surface is flat and the drainage poor. The type is timbered with pine, cabbage palmetto, gums, bays, and saw palmetto. When drained it is likely that sugar cane, corn, oats, forage crops, and cotton will do well.

Coxville very fine sandy loam.—The soil is a dark-brown, mellow, very fine sandy loam of high organic-matter content and from 10 to 24 inches deep. The subsoil is a drab to yellowish fine sandy clay which quickly grades into compact, rather plastic clay, mottled with yellow, drab and bright red. The type occurs as flat and slightly depressed areas, usually as savanna or sparsely timbered land. When drained it produces good crops of cotton, corn, oats, forage, and strawberries. Applications of lime are quite beneficial.

Durant very fine sandy loam.—This type consists of a yellowish-brown very fine sandy loam underlain by a pale yellowish-gray very fine sandy loam slightly heavier than the surface soil. The soil varies in texture from a heavy very fine sandy loam to light loam. Thin layers of limestone occur throughout the type and fragments are occasionally scattered over the surface. The topography is broken and hilly and the surface is cut by numerous V-shaped valleys. Little of the type is under cultivation, the greater part being used for grazing. It is best adapted to this purpose, as it is too hilly and badly eroded to permit of easy cultivation.

Hyde very fine sandy loam.—The soil is a gray to dark-gray very fine sandy loam, from 6 to 8 inches deep. The subsoil is a light-gray, compact very fine sand or fine sandy loam. The type occupies ridges and low, flat, poorly drained situations. With the establishment of good drainage conditions it is well suited to cotton, corn, oats, potatoes, and vegetables.

Mattamuskeet very fine sandy loam.—The soil consists of a silty very fine sandy loam 36 inches deep. When wet the type is brown, but on drying out

it becomes dark-gray or drab. In places a bluish silty clay or fine sandy clay is encountered at depths ranging from 12 to 30 inches. When reclaimed, this soil should produce fine crops of corn, oats, peas, soy beans, and cabbage.

Norfolk very fine sandy loam.—The soil is a gray to dark-gray very fine sandy loam of silty feel. Below the first few inches a yellowish very fine sandy loam is encountered, which extends to a depth of 6 to 12 inches. The subsoil is a yellow or light-brown silty loam to silty fine sandy clay sometimes mottled with reddish and grayish colors. The type is friable and easily tilled. It tends to bake and harden after heavy rains unless cultivated under proper moisture conditions. The surface configuration varies from level to undulating or gently rolling, and is well suited to agriculture. The level and depressed areas need ditching. The type is highly adapted to cotton. Corn, oats, sweet potatoes, and peanuts do well. Bright tobacco gives very fair results.

Area and distribution of the very fine sandy loams.

Soil name.	State or area.[1]	Acres.
Norfolk very fine sandy loam	Florida 5; North Carolina 21, 24	41,536
Coxville very fine sandy loam	Georgia 3, 10; South Carolina 7	38,016
Mattamuskeet very fine sandy loam	North Carolina 16	35,072
Hyde very fine sandy loam	Georgia 3; North Carolina 16	25,984
Durant very fine sandy loam	Texas 9	2,752
Bladen very fine sandy loam	Georgia 10	960
Total		144,320

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loams constitute the best medium-late truck and all-around general farming soils of the Atlantic and Gulf Coastal Plains. They are easily kept in good tilth and are retentive of moisture. Vegetables mature rather late, but the yields are sufficiently heavy and the quality good enough to overcome certain disadvantages in climate and transportation. By the time vegetables produced on the loams in the southern portion of the region are ready for shipment an abundance of early truck is maturing on the earlier sandy soils in the northern districts. This limits competition on the loams to those districts having sufficiently adequate transportation facilities to compete with the trucking districts to the north, yet the loams are valuable soils for supplying the local markets. In Georgia and South Carolina competition prohibits the use of the loam soils by truckers, except for the production of noncompetitive crops like Bermuda onions, and the growing of products for immediate local consumption and for canning. Such crops as cauliflower, spinach, kale, eggplant, squash, asparagus, carrots, parsnips, Irish potatoes, tomatoes, onions, cabbage, celery, beets, and cucumbers give the best results. Strawberries and raspberries also do very well. The earlier truck crops, even including tomatoes, when grown on soils of this texture may not find a ready market at good prices, and provision should always be made to can or otherwise preserve them for winter use.

Good yields of cotton, corn, and forage crops, such as cowpeas, velvet beans, crimson clover, vetch, and sorghum are secured. Heavy yields of sugar cane are made, but the sirup is inferior in quality to that from the lighter-textured soils. The Cuban type of cigar-filler tobacco does well on certain of the loams, but in the case of wrapper tobacco the texture of the leaf averages rather too coarse for the trade.

It is upon the loam soils that small grains and grass are advantageous. Good yields of wheat, oats, and rye are secured and grass does fairly well. For general farming a heavier farm equipment is absolutely necessary to bring the soils to a point of highest efficiency. Owing to a failure to appreciate this condition and provide more expensive equipment the possibility of the soils of this grade have not been fully realized in many sections. The group comprises the best general-purpose soils of the Coastal Plains province, particularly of the North Atlantic division.

South of the Potomac River-Chesapeake Bay region, in the Coastal Plains province, the loams are comparatively inextensive, yet they are important

for the reason that they are good, productive soils. In the North Atlantic division the Sassafras loam is widely developed and is considered the best general-purpose soil of that region. The Leonardtown loam includes a large area of poor to fair farming land in the Chesapeake Bay section.

Other important loams are the Greenville of southwest Georgia, Alabama, and northern Mississippi, the Norfolk of scattered occurrence throughout the inner division of the Coastal Plains east of the Mississippi River, the Portsmouth of the Flatwoods, the Victoria of the Texas Coastal Prairie, and the Houston and Webb loams of north-central and western Texas.

Brennan loam.—The soil to a depth of 6 to 12 inches consists of a gray to light grayish-brown loam, whose texture varies between a heavy fine sandy loam and a silt loam. It contains very little organic matter, a fact which, together with a high lime content, often gives the surface a white floury appearance. The subsoil is of very much the same texture as the surface soil, consisting of a gray to almost white loam, which contains a high percentage of lime. The type has been formed from calcareous deposits of sand, silt, and clay of Pleistocene age. Except for a few minor depressions the surface is almost level, with sufficient slope to give good drainage. In its native state the type supports a dense growth of mesquite, chaparral, and cactus, the latter being especially heavy. The type is well adapted to the production of cabbage, onions, radishes, cucumbers, and various other truck crops, as well as alfalfa, sugar cane, pecans, and figs. This type should prove one of the very best in the Rio Grande Valley for fruits and grapes. On account of its location, ease of cultivation, and of irrigation it is one of the most popular soils of this section.

Caddo loam.—The type consists of a dark-brown, brownish-gray, or gray silty loam from 6 to 16 inches in depth, grading into a clay loam subsoil 8 inches deep, resting upon mottled clays. The type owes its origin to coastal deposits and is found in poorly drained areas or depressions containing scattered sand mounds. It is an excellent rice soil.

Crockett loam.—The surface soil to a depth of 8 to 12 inches is quite heavy and consists of a dark-gray loam to clay loam. It contains organic matter with some fine sand and occasionally small amounts of rounded, water-worn gravel. The subsoil to a depth of 36 inches is a red sandy clay mottled with yellow and gray. The sand varies from medium to fine and the red color may appear in streaks. The type occupies comparatively level slopes adjoining stream courses and has good drainage. It is probably derived from the intermingling of some of the Houston black clay material with surrounding types and represents the occurrence of the old San Antonio prairie. It is largely under cultivation and devoted principally to cotton and corn.

Durant loam.—The surface soil consists of a dark-gray or grayish-brown loam from 10 to 15 inches deep, containing a relatively high proportion of fine and very fine sand and silt. The subsoil is a dark-brown or yellowish-brown, stiff silty clay. The subsoil in the lower-lying areas is sometimes mottled and also shows a few reddish-brown iron stains, the result of decomposed iron concretions. The topography varies from almost level to slightly rolling. Under average seasonal conditions drainage is good. The type is derived principally from the Woodbine formation of the Upper Cretaceous age. Corn and cotton are the principal crops, and peanuts and fruit also do well.

Duval loam.—The soil consists of a reddish-brown to red loam about 10 inches deep, containing varying amounts of fine and medium sand. The subsoil varies from a bright red to reddish-brown or reddish-yellow sandy clay, the red color being most pronounced. The type is derived from the weathering of early Tertiary deposits. Cotton, corn, and sorghum are the principal crops grown, the yield varying with the rainfall. The type is inclined to be droughty.

Edna loam.—This type consists of 10 or 12 inches of a gray or dark-gray loam to silt loam, resting upon a dark-gray impervious clay loam or clay which at 20 to 24 inches grades into a gray clay often mottled with yellow. It has been formed from the weathering of the noncalcareous Pleistocene deposits of the level Gulf Coastal Plains. The surface is ordinarily almost level and drainage is often poor. Most of the type is still used as pasture, but if properly drained good yields of cotton and corn may be secured. The level surface and impervious character of the subsoil makes it well suited to the production of rice.

Elkton loam.—The soil varies from 6 to 10 inches in depth and consists of a dark-gray, silty medium loam becoming lighter in lower portions. The subsoil is a heavy, clammy silt loam about 30 inches in depth. It grades from gray or drab to an intense mottling of gray, red or yellow, and brown colors in lower

depths. Alternating thin strata of sand and clay are common at 30 inches and below, the sand being always saturated with water. The type occurs as poorly drained depressions and flat land around heads of small streams. It is derived from marine deposits which have weathered under poor conditions of drainage. Sweet and black gum, white oak, and maple are common. Under present conditions of drainage it is not suited to general farming, but is a fair grass land. Some wheat is grown.

Gadsden loam.—The soil consists of a dark yellowish gray loam of light texture, from 8 to 18 inches deep, and is underlain by a somewhat heavier yellowish-gray loam or clay loam. The type occurs as moderately high bottoms and bluffs. It is locally known as hammock land and supports a growth of hardwood timber. The soil is well drained. It is fairly productive and is adapted to cotton, corn, and fruit.

Glenn loam.—The soil varies from a heavy fine sandy loam to a loam or silty loam and is about 10 inches deep. The first inch is gray or grayish yellow, and below this the color varies from a light yellow to a brownish yellow. The subsoil is a compact yellow loam, sometimes mottled with gray below 24 inches. The type occupies level to gently rolling elevated areas with good drainage. It is derived from weathered Lafayette or possibly a more recent formation. Carboniferous sandstone is frequently encountered at from 4 to 6 feet, and may have contributed to the soil formation. The type supports an open growth of oak and hickory, and native grasses grow well. Corn, cotton, and oats are the principal cultivated crops. Apples do well, while peaches are not usually successful.

Grady loam.—The type consists of a dull-brown, light loam underlain at a depth of 15 to 20 inches by an extremely stiff and rather plastic drab clay mottled slightly with red and yellow. It occurs in sink holes and as peculiar flat-bottomed depressions which resemble stream bottoms in topography, and lie at depths 20 to 30 feet below the general upland level. The water of streams running into this land spreads out and sinks into the ground, there being no drainage outlet. Sink holes in the underlying limestone are common. Some of the elongated areas are locally styled " slough land " on account of the peculiar drainage features. Mayhaw and water oak constitute the main part of the sparse or clumpy timber growth. The origin of the type is doubtful, but in the main it is probably derived from the earlier portions of the formation giving rise to the Orangeburg and Wabash soils. The underlying limestone gives rise to or has influenced the subsoil material. None of this land is under cutlivation.

Greenville loam.—The soil is a brownish to reddish loam or silt loam from 3 to 5 inches deep. The subsoil is a red, friable, heavy clay loam extending to a depth of 36 inches, where it usually becomes mottled with red and yellow. Aeration and drainage are facilitated by the quantities of fine iron concretions present in the subsoil. The type occurs as nearly level or slightly rolling areas on divides. Drainage is only fair and could be improved by the use of tile. The material is derived from weathering of the Lower Claiborne formation of Eocene age. The type is an excellent soil for cotton and oats and gives good results with corn and grass. Ordinarily it is not well adapted to truck crops. It readily responds to any system of improvement and is easily maintained in a high state of productiveness.

Houston loam.—The soil is a gray to light-brown loam, with an average depth of 10 inches, containing a considerable amount of silt. It is friable and when well cultivated has a desirable tilth. The subsoil is a drab to slate-colored silty clay, containing noticeable amounts of fine sand. It becomes heavier with depth, and at 36 inches grades into a stiff, plastic, silty clay, often slightly mottled and containing a small percentage of fine sand. Small rounded pebbles are sometimes encountered in both soil and subsoil. The type occupies slightly rolling upland prairies, and except in occasional depressed areas the drainage is good. The Houston loam occupies a position between the heavy black clay lands of the prairie and the sandy timber lands, and has been formed by the intermingling of material from these two soil classes. It is best adapted to early maturing crops, as the late summer droughts often seriously affect the yields. Good crops of cotton, corn, oats, and sorghum are produced.

Hyde loam.—The type consists of a black loam to heavy loam from 10 to 14 inches deep, rich in organic matter, underlain by a black, plastic clay, frequently having a bluish cast. It occupies poorly drained depressions and level areas. With proper drainage and applications of lime good yields of corn, oats, lettuce, strawberries, cabbage, celery, cauliflower, and onions can be secured. Rice does well without drainage.

Lake Charles loam.—The soil is a dark-brown, black, or bluish-black loam, with a high percentage of organic matter. At 14 inches the subsoil of clay loam is encountered, and this is underlain by a mottled clay. The type owes its origin to local swamp areas into which fine loam has drifted. It is a heavy soil, difficult to till, but when properly cultivated it makes excellent rice land.

Lamar loam.—This type consists of a brown or yellowish-brown loam to an average depth of 12 inches, underlain by a lighter colored calcareous clay. The subsoil contains fragments of limestone and lime concretions. The topography is rolling to rough and the surface is badly eroded. The type is derived from material of the same age as the Austin chalk, though in appearance it resembles a very calcareous marl. It owes its characteristics to this chalk material and to the rapid erosion which has removed the surface before thorough decomposition into the black clay could take place. The type is used for pasture and supports a scattered timber growth of oak and other hardwoods.

Leonardtown loam.—The soil is a yellow silty loam resembling loess, 9 inches deep, and underlain by a red and mottled clay loam subsoil, with peculiar interlocking clay lenses and pockets of sand. The type occupies slightly rolling upland. It is a good soil for general farming, wheat, and grass. Extensive areas of this type are in waste land or grown up in white oak and pine forests. Some of the more level areas could be improved by underdrainage. The soil is deficient in organic matter and lime.

Lomalto loam.—The surface soil consists of a dark-brown loam containing a rather small amount of fine sand. The first 2 inches are often a fine sandy loam more or less subject to wind drifting, which gives the surface the appearance of a fine sandy loam. This sand accumulates around clusters of vegetation, leaving the intervening areas bare and disclosing plainly white incrustations of salt. Such areas have a very hard, baked appearance. The loamy surface soil extends to a depth of 6 to 10 inches and is underlain by a very compact, hard clay loam of a drab or gray color. The soil has been formed from unconsolidated marine deposits and represents a transition stage between the Victoria loam and the material which is now being deposited in the flats along the coast. The surface is generally level. The native vegetation is principally sacahuistle grass, with a scattering of mesquite and huisache near the boundary of the Victoria loam. Under present conditions the type is unfit for cultivation owing to its salt marshy character. It is devoted to pasture.

Lufkin loam.—The soil consists of a dark-gray loam from 3 to 10 inches deep, containing considerable organic matter. The subsoil is a stiff, compact, dark-colored sandy clay. The surface is flat, with a few gently rolling areas, and drainage is generally poor. The type is derived from the weathering of Lafayette deposits. Corn and cotton are the principal crops, yielding from 25 to 35 bushels and from one-fourth to three-fourths of a bale, respectively, per acre. The type is also adapted to truck and strawberries.

Maverick loam.—The soil consists of a brownish to light-gray loam from 10 to 12 inches deep. The surface 3 to 6 inches contain considerable amounts of fine to medium sand, giving the soil the appearance of a sandy loam. Under this shallow covering, however, the soil rapidly becomes heavier, and at a depth of 5 to 8 inches contains enough fine material to give it the texture of a heavy loam. The subsoil is lighter in color and heavier in texture than the soil. It consists of a light-brown to yellowish-brown loam, which becomes heavier with depth, until at 3 feet it consists of a compact, light-brown to yellowish-brown clay loam or clay. Both soil and subsoil are highly calcareous, but low in organic matter. The type is derived from the coarse, sandy deposits of the Webb series and the heavy underlying calcareous clays. The topography varies from almost level to gently rolling, the type occupying valleys, with occasional small areas on low knolls and ridges. The greater part of the type is used for pasture, although limited areas are used for truck, cotton, and forage crops with good results. Part of it lies within what is known as the "artesian belt" of Texas, and such areas could doubtless be irrigated by water obtained from deep wells. The native vegetation consists of a sparse growth of mesquite, chaparral, and prickly pear.

Norfolk loam.—The soil is a brown loam or fine sandy loam, usually containing a very small amount of fine gravel. The subsoil is a yellow loam with a high content of sand and frequently underlain by a medium grade of yellow sand or gravel. The type occupies level areas, usually terraces along rivers and tidal estuaries. The soil is easily tilled, well drained, and produces fair yields of general farm crops. It is especially adapted to sugar corn, peas, and tomatoes for canning purposes, and also to peaches. It is too heavy for

early truck and not sufficiently heavy to be classed as a general farming soil.

Portsmouth loam.—This type consists of a dark-gray to black, fine-textured loam about 12 inches deep, underlain by a gray or somewhat mottled heavy loam subsoil which often grades into a mottled gray or yellow silty clay. It occupies flat upland areas with naturally poor drainage. When properly drained and cultivated, it is well suited, according to locality, to corn, cotton, sugar cane, and forage crops.

Sassafras loam.—The soil is a brown or yellowish-brown moderately heavy loam, varying in depth from 8 to 16 inches and occasionally carrying some fine quartz gravel. The subsoil to a depth of 24 inches is a reddish-yellow or a reddish-brown heavy loam, slightly heavier than the soil. In the lower depths it passes into a reddish-brown coarse sandy loam. The surface varies from broken stream slopes to nearly level uplands. Drainage is good. The type is derived from marine deposits weathered under good conditions of drainage. It is well adapted to wheat, corn, grass, and all kinds of forage crops, and also to such crops as tomatoes, beans, and cabbage.

Susquehanna loam.—The soil is a dark-brown loam or clay loam about 6 inches deep. The subsoil is a stiff, plastic, mottled clay, nearly identical with the subsoil of the Susquehanna fine sandy loam, with which this type is always associated. The type occurs on the uplands and is well drained. It is an excellent cotton soil and produces good yields of oats. It is somewhat droughty for corn. Some truck crops, such as onions and cabbage, would do well.

Victoria loam.—The soil to a depth of 10 or 12 inches varies from a light-brown to dark-gray loam and passes gradually into a grayish loam, becoming heavier and more compact with depth. Small deposits of lime are found in the subsoil. The type occurs throughout the uplands as level or gently undulating areas of good surface drainage. It is formed largely from light wind-blown material mixed with the heavier underlying clays of Tertiary age. It is a very productive soil and well adapted to truck, cotton, corn, and other general farm crops.

Wilson loam.—The soil consists of a dark-gray or dark brownish gray loam 9 or 10 inches deep. The subsoil is a mottled red, yellow, gray, or drab silty clay or heavy loam, which becomes heavier with depth. The topography is level to gently rolling and natural drainage is good. Only in exceptional cases is there a tendency to wash, while on very level tracts artificial drainage may be necessary. The type represents a gradation between Houston black clay and Lufkin fine sandy loam. Much of the type is in pasture, but under cultivation good crops of cotton and corn are secured.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Houston loam	Mississippi 3; Oklahoma 2; Texas 3, 7, 11, 12, 23, 26, 27, 28, 31	1,962,432
Victoria loam	Texas 12, 27, 28	647,424
Duval loam	Texas 28, 33	214,272
Edna loam	Texas 12	209,664
Leonardtown loam	Maryland 2, 8, 9; Virginia 6, 12	196,514
Norfolk loam	Alabama 2, 37; Florida 1; Mississippi 2, 5, 18; North Carolina 6	194,048
Maverick loam	Texas 28	175,104
Portsmouth loam	Alabama 2, 29; Georgia 10; Maryland 4; Mississippi 11, 18; North Carolina 6, 7, 8, 9, 19, 20, 23, 24; South Carolina 10, 15	163,648
Brennan loam	Texas 27	142,848
Sassafras loam	Maryland 1, 2, 4, 10; New York 7	128,356
Durant loam	Texas 9, 11	73,216
Lomalto loam	Texas 12, 27	66,816
Caddo loam	Louisiana 8	51,280
Glenn loam	Alabama 10, 27	42,688
Greenville loam	Alabama 2, 17, 29, 37; Florida 1; Louisiana 2, 9, 14; Mississippi 5, 8	38,656
Wilson loam	Texas 3, 10, 11, 29	29,056
Crockett loam	Texas 3, 28	28,288
Gadsden loam	Mississippi 11	14,592
Lake Charles loam	Louisiana 1, 8	6,378
Hyde loam	Georgia 3, 10	5,824
Lamar loam	Texas 7	5,696
Lufkin loam	Texas 18	5,376
Susquehanna loam	Texas 24	3,392
Elkton loam	Maryland 4	2,624
Grady loam	Georgia 11	896
Total		4,409,088

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony loam phase is relatively inextensive and confined principally to: (1) The Susquehanna regions, where it is locally developed, and where iron-cemented sandstone is encountered sometimes in sufficient amount to give the soil a decidedly stony character; and (2) to the rough belt extending from southwest Alabama nearly to central Mississippi, the region of the Claiborne formation, where fragments of iron-cemented sandstone, quartzite, and a light-colored, soft, siliceous rock are common.

The stony loams usually have rough topography, and cultivation is otherwise made difficult by the abundance of rock fragments.

Susquehanna stony loam.—This type consists of a gray or reddish-gray sandy loam from 6 to 12 inches deep, with a stone content of varying sizes in which ferruginous sandstones predominate. The subsoil is somewhat higher in clay content, often assumes a red color, and generally carries a greater proportion of stony fragments than the soil. The type occupies rough, hilly districts or occurs as eroded spots on bodies of Susquehanna gravelly loam. It is generally uncultivated and is utilized only for grazing or forestry. The native timber growth consists of shortleaf pine, white, post, and blackjack oaks, and hickory.

Area and distribution of the stony loam.

Soil name.	State or area.[1]	Acres.
Susquehanna stony loam	Texas 6	1,024

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

Like the gravelly sandy loams, the gravelly loams are frequently confined to rolling and dissected areas. Those of smoother topography often have a fair agricultural value, occasionally only slightly less than that of the corresponding types of loam soils. Even under such conditions the gravel content is sufficient to render cultivation somewhat difficult, a feature which constitutes a distinct variation from the corresponding loam.

Crockett gravelly loam.—The soil consists of a yellowish-brown fine sandy loam or loam about 8 inches deep, with a content of quartz and ferruginous sandstone gravel ranging from 15 to 60 per cent. The subsoil is comparatively free from gravel, and to a depth of 36 inches consists of a yellowish, very stiff, plastic, slightly sandy clay. The topography is gently rolling and the type is well drained. The soil is residual in origin, derived from the underlying clays and fossiliferous sandstone, probably of late Cretaceous or early Tertiary age. It is sparsely timbered and only a small part of it is in cultivation. It should be used for early truck crops, such as garden peas, lettuce, radishes, blackberries, and dewberries.

Glenn gravelly loam.—The surface soil consists of a gray silt loam from 6 to 8 inches deep underlain by a gray to reddish-brown silty clay. Both soil and subsoil contain a large amount of rounded and subangular quartz and chert gravel, with fragments of ironstone or conglomerate. The surface is hilly and broken and drainage is excessive. The soil is derived from unconsolidated sediments of the Tuscaloosa formation. It is developed over relatively broad areas in northwestern Alabama. Most of the type is too sterile and droughty for profitable cultivation, and is better adapted to forestry.

Greenville gravelly loam.—The soil to an average depth of 6 inches is a light brown to reddish-brown loam, carrying fragments and concretions of ferruginous rocks, commonly of hematite or ferruginous argillite. The subsoil is a red, friable clay in which the ferruginous rock material is so abundant that it is usually impossible to bore with an auger to any great depth. The ferruginous gravel fragments materially lower the agricultural value of the type, except possibly for peaches, plums, and pasturage.

Lufkin gravelly loam.—The soil is a gray fine sand, sometimes considerably heavier in depressed areas than in higher situations, and is underlain by a heavy sandy clay which varies in color. Both soil and subsoil contain large quantities of gravel. The surface is generally rough and hilly, and the drain-

age thorough. The type is largely devoted to pasture. Yields of about one-third of a bale of cotton and 15 bushels of corn per acre are secured on some of the less gravelly areas.

Norfolk gravelly loam.—The soil is a gray sandy loam from 6 to 30 inches deep, containing relatively large proportions of coarse to medium sand and from 15 to 50 per cent of gravel and iron concretions. The subsoil varies from a sticky sandy loam to a light sandy clay. The gravel is generally mixed evenly throughout soil and subsoil and is occasionally found on the surface. This type occupies terraces and gently to steeply rolling plains marked with occasional ridges and hills. The surface configuration, combined with its open texture, gives the type excellent drainage. It supports a scattered growth of oak and pine. Corn, cotton, rye, buckwheat, truck crops, peaches, and wrapper tobacco are grown, according to locality, but the yields are low.

Sassafras gravelly loam.—This type consists of a brown or yellowish-brown loam carrying from 10 to 25 per cent of medium-sized, rounded quartz gravel. The subsoil is a reddish colored material considerably heavier than the soil. The type occurs as narrow strips along stream slopes or as small patches on upland slopes. Its origin is due to removal of soil material by wash, which has left exposed the underlying gravelly material. It has excellent drainage. Where not too steep it is well adapted to wheat, corn, grass, clover, and forage crops. Tomatoes, beans, and cabbage can be grown. Alfalfa does well.

Susquehanna gravelly loam.—The soil is a grayish-brown medium to fine sandy loam, from 6 to 15 inches deep, containing from 40 to 60 per cent of rock fragments and gravel, mainly iron sandstone. It is underlain by a red, occasionally mottled, tenacious clay subsoil, which also contains sand, gravel, and stones. It occurs as broken areas along streams and on hills. Tillage is difficult, but fair crops of cotton and corn can be grown with careful fertilization.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Susquehanna gravelly loam	Alabama 3, 17, 30; Louisiana 9; Maryland 1; North Carolina 22; Texas 6, 20, 29.	191,738
Sassafras gravelly loam	Maryland 1, 4, 6; New Jersey 1, 3; New York 7	164,678
Norfolk gravelly loam	Alabama 24, 25, 30; Mississippi 4, 6; Virginia 6	140,736
Glenn gravelly loam	Alabama 10	69,312
Lufkin gravelly loam	Texas 3, 18	58,112
Crockett gravelly loam	Texas 24	3,008
Greenville gravelly loam	Georgia 5	1,600
Total		629,184

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The silt loams are adapted to late truck and vegetables for canning purposes and to heavy farm crops. They furnish also a small supply of fresh vegetables for local southern markets. Vegetables mature so late on these soils that only special crops give profitable returns. The different members are easily worked, but are more inclined to become compact after rains than the loams, on which account more intensive cultivation and heavier farm equipment are required to maintain productivity.

The well-drained silt loams give heavy yields of cabbage, tomatoes, beans, spinach, lettuce, and Irish potatoes of good keeping qualities. Tomatoes, asparagus, and cauliflower are profitably grown for canning.

The range of farm crops adapted to this group of soils is narrower than on the lighter soils, but the yields of such as can be produced are heavier. Corn, wheat, oats, clover, vetch, rice, and grass do particularly well. Good crops of cotton are secured with normal rainfall. In districts infested with the boll weevil early maturing varieties must be grown in order to save the crop from the increased activities of this pest in the latter part of the growing season.

Hay is an important crop on this group of soils. They also make good pasture land. With the good grazing possible, dairying and stock raising are profitable industries. As a rule the silt loams are the most difficult to control and maintain in a high state of productivity of any of the important groups in

the province. This is due to their peculiar structure and their liability to become compact, except under the most careful control. They require a heavier farm equipment than the loams.

The proportion of level land is relatively greater than with any of the other groups, the soils occupying the more nearly level areas of the Coastal Plains. Drainage is therefore somewhat less well established except in case of those soils having a coarser textured, open substratum, such as the Sassafras silt loam. Usually, however, the drainage can be easily improved either by ditching or tiling.

In the North Atlantic division the Sassafras and Elkton silt loams are the most extensive representatives of this group. The silt loams are fairly important in the Flatwoods, where the Scranton, Coxville, and Portsmouth types occupy occasional fair-sized areas. It is in the level sections of lower Louisiana and southeastern Arkansas that the silt loams appear as the most important regional group. Here the Crowley, Monroe, Acadia, Hammond, and Landry silt loams are the dominant soils in point of area and from an agricultural standpoint.

The silt loams are of comparatively little importance in the inner division of the Coastal Plains east of the Mississippi River, although some fair-sized areas of Norfolk silt loam occur near the boundary of the Flatwoods and in Mississippi. The Oktibbeha silt loam occupies scattered areas through the "black prairie belt" of Alabama and Mississippi, while the Lufkin and Pheba are of considerable importance in Mississippi. The silt loams of Mississippi possibly bear, in part at least, a close relationship to the Yellow Loam (loessial) formation. The Lufkin silt loam occurs in scattered areas through east Texas.

Acadia silt loam.—The soil is a white or light ashy-gray, loose silt loam from 16 to 30 inches deep, underlain by a mottled brown and yellow silty clay. The type occurs in rolling areas, and only little of it is cultivated.

Berzelia silt loam.—The soil to an average depth of 6 inches is a grayish, sticky silt loam. The subsoil is a nearly white, compact silt loam, becoming yellowish or mottled yellow and gray in the lower section. The type is developed in benchlike situations and as slopes near the source of streams. The soil is cold and acid, and is best suited to grass.

Coxville silt loam.—The soil is a light-gray to dark-gray silty loam to silt loam from 5 to 8 inches deep. The more uniform areas always carry a high percentage of silt, while in the surface few inches over some of the more rolling and less typical areas the soil is a fine sandy loam to light loam. The subsoil is a plastic, tough, and impervious clay mottled with yellow, reddish brown, and red. The surface configuration varies from gently rolling to undulating. A few areas occur in slight depressions in which the organic-matter content is higher and the color darker. The soil material is derived from the fine deposits of the Columbia formation, laid down in quiet waters. The drainage is rather poor, and the type requires ditching before it can be cultivated advantageously. The type differs from the Portsmouth in that it has not been subjected to swampy conditions, and in its generally lighter color and the more intensive mottling and predominance of red colors in the subsoil. Clods are easily formed unless a good tilth is maintained through deep and timely cultivation. Heavy applications of lime and coarse barnyard manure or green manure are required to improve its structure. Grass, cotton, corn, and forage crops do quite well. Some varieties of strawberries find the type well suited to their requirements.

Crowley silt loam.—The soil is a silt loam to an average depth of 10 inches. When wet the soil is brown, but upon drying it becomes ashy gray. It is usually underlain by a gray or mottled gray and yellow silt loam to a depth of 16 to 30 inches. Below this a mottled-gray, yellow, and red, heavy, impervious silty clay is encountered. Both soil and subsoil contain iron and lime concretions. The type occurs as level or slightly rolling prairies and is one of the finest rice soils of southern Louisiana. During wet seasons water often stands over the surface, but when well drained the type is adapted to cotton and oats.

Elkton silt loam.—The soil to a depth of about 10 inches consists of a grayish silt loam and is loose and floury in well-cultivated fields, but has a tendency to run together when wet and bake upon subsequent exposure. The subsoil has a grayish color, somewhat darker than the soil, and generally mottled with yellow and brown iron stains. The clay content increases slightly with depth. At 3 or 4 feet alternating beds of clay and sand are encountered, the latter being always saturated with water. The type is derived from marine deposits which have weathered under poor conditions of drainage. Level areas with sluggish surface drainage are found on low necks between estuaries and also occasionally

in the uplands, where drainage is poor. Most of the type is in cultivation. It is an excellent soil for timothy and gives good results with corn. Wheat does not do especially well. The soil is difficult to manage in wet seasons and can be greatly improved by manuring and drainage.

Hammond silt loam.—The soil is a silty loam or very fine sandy loam, with an average depth of 15 inches. The surface has an ashy-gray color which changes to dark gray or brown when wet. The gray color may continue through the entire depth of the soil, but frequently changes to yellowish at about 4 or 5 inches from the surface. The subsoil is a yellowish, heavy silty clay, with drab, brown, or red mottling. A few iron concretions are found. The type usually occupies level areas, and the drainage is generally poor. It is derived from the Port Hudson clays, is deficient in organic matter, and is not a naturally productive soil. It is fairly well suited to oats, crab-grass hay, sugar cane, and small truck. With heavy fertilization large yields of strawberries are secured. The principal forest growth is longleaf pine.

Hyde silt loam.—The type consists of a dark-gray to black mellow loam which is high in organic matter and has a depth of 36 inches. The material becomes lighter in color upon drying out. The surface configuration varies from flat to slightly ridgy. It is well adapted to corn, oats, cotton. and soy beans. In years of good seasonal conditions corn varies from 30 to 50 bushels, oats from 30 to 75 bushels, cotton from two-thirds bale to 1½ bales, and soy beans about 25 bushels per acre. Potatoes, black peas, the Mattamuskeet apple, figs, celery, and vegetables also do well.

Landry silt loam.—The soil is a dark-brown silt loam 10 inches deep, underlain by a heavy brown clay subsoil grading into greenish-yellow or drab clays. The subsoil contains lime and iron concretions and differs from that of the Crowley silt loam in being more friable, less plastic, and having a more pronounced silty texture. The soil is productive, but the surface is so rolling that irrigation is impracticable, and rice culture is therefore impossible. It is fairly well adapted to cotton.

Lufkin silt loam.—The soil of this type varies from a heavy fine sandy loam to a silty loam about 10 inches deep. The sand is very fine, and in most cases the soil appears more like a silt loam. The first 2 or 3 inches are dark gray owing to accumulations of organic matter. At from 3 to 10 inches a lighter gray or yellowish-gray color appears as the loam content decreases. Both the texture and the color of the subsoil show wide variations, though it is usually a mottled-gray, heavy silt loam, frequently containing iron concretions and some fine sand and increasing in tenacity to a depth of 3 or 4 feet, where a stiff clay is encountered. The soil becomes more sandy and the subsoil brighter in color with elevation, the subsoil of the highest areas being usually a dark or dirty yellow silty clay. The surface soil varies very little, and then only in the silt content. The type is sedimentary in origin, and its topography is level to moderately rolling. Cotton is the principal crop, and oats do well under favorable conditions. The type is not considered good for corn, and peaches and pears do not thrive, but grapes and plums give excellent results.

Mattamuskeet silt loam.—The soil is a black, mellow silt loam or mucky silt loam from 10 to 24 inches deep. The subsoil is usually a gray to dark-gray loamy fine sand. In places it is as heavy as a fine sandy loam or even a silt loam. The content of organic matter is high and the soil becomes very light when dry. The type occurs just above normal water level and is subject to inundation. It is well suited to corn, oats, cotton, celery, onions, cabbage, and soy beans.

Monroe silt loam.—The soil is a fine sandy or silty loam 10 inches in depth and is underlain by a yellow or red silty clay subsoil, usually mottled with white or brown below 2 feet. The type occurs as low terraces or on low hills. The forest growth consists mainly of oak and pine. Very little of the type is under cultivation and yields are low. Cotton can hardly be made to yield one-half bale per acre, and corn yields are proportionately low.

Norfolk silt loam.—The type consists of a brown, mellow silt loam 10 inches deep, underlain by a heavy yellow silt loam. It occupies flat to undulating areas and is well suited to the general farm crops, wheat, corn, cotton, and grass giving the best results. A number of late vegetables, such as cabbage, tomatoes, Irish potatoes, and spinach, do well.

Oktibbeha silt loam.—The soil consists of a light-brown, rather compact silt loam from 7 to 10 inches deep, having a grayish cast in the immediate surface section. The subsoil is a yellowish-brown silty clay loam, which quickly grades

into yellowish-red or reddish-yellow stiff silty clay mottled with yellow, brown and red, or gray, yellow, and red. The type is developed as nearly flat areas, and in its virgin state supports a heavy growth of post oak and hickory. Cultivation is somewhat easier than on the Oktibbeha clay. The type needs organic matter to overcome the tendency to bake. Fair to good yields of cotton and corn are secured, especially with moderate fertilization. The type is well suited to oats, wheat, cowpeas, soy beans, Johnson and Bermuda grass, lespedeza, bur clover, vetch, Irish potatoes, and cabbage.

Pheba silt loam.—This soil is a yellowish-gray to light-brown silt loam from 6 to 10 inches deep, and is underlain by a yellow silt loam frequently mottled with light gray below 24 inches. The type is derived from the loess of the Yellow Loam formation deposited over the Eocene lignitic clay. The topography is gently undulating, but on account of the nearness of the underlying heavy clays drainage is generally deficient, limiting the agricultural value of the type.

Portsmouth silt loam.—The soil consists of a gray to dark-brown friable silt loam about 9 inches deep. It is frequently compact and inclined to puddle, and if plowed when too wet it forms clods, though these break down quite readily in subsequent cultivation. The subsoil is a gray or mottled gray and yellow heavy silt loam, becoming heavier and somewhat more waxy with depth. It occurs as flat, slightly depressed, or low-lying areas, which generally require artificial drainage. The type has been formed by the deposition of fine materials in comparatively quiet water during the more or less complete submergence of the Atlantic Coastal Plain. When well drained it is adapted to corn, hay, and small grains, and in the South to such vegetables as cabbage, kale, collards, etc. Moderate yields of cotton are also secured.

Ruston silt loam.—The soil to an average depth of 7 inches consists of a gray to grayish-brown silt loam in places running high in very fine sand. The subsoil is a yellowish-red to dull-red silt loam which quickly grades into a silty clay loam having in its lower section occasional grayish mottlings and a slightly plastic structure. The type occupies undulating to gently sloping or gently rolling country. Cotton, corn, and forage crops give good yields with moderate applications of fertilizers, deep fall plowing, and the addition of organic matter.

Sassafras silt loam.—The soil to an average depth of 8 or 10 inches is a light-yellow, friable silt loam containing considerable fine sand, with little or none of the medium grade. The subsoil consists of a compact, reddish-yellow or brownish silt loam, which increases slightly in clay content with depth and shows a tendency to granulate at depths ranging from 15 to 30 inches. It is derived from marine deposits which have weathered under fair conditions of drainage. The type occupies flat to undulating interstream divides with fair natural drainage, although ditches are sometimes required to remove surface water. Grass, forage crops, wheat, clover, and timothy all do well. It is an excellent soil for corn in favorable seasons. It should be restricted in use to crops which require long growing seasons and for which a continuous moisture supply is of first importance.

Scranton silt loam.—The very dark silt loam soil of this type is from 6 to 10 inches deep and is underlain by yellow or grayish-yellow silty loam or silty clay, the line of demarcation between the soil and subsoil being less sharp than in the other members of this series. The surface is level or slightly sloping toward drainage channels or areas of the Portsmouth soils. Drainage is deficient. The natural growth is mainly shortleaf pine and wire grass. When cleared and drained it is an excellent soil for grains and grasses.

Susquehanna silt loam.—This type consists of 5 to 8 inches of brown, friable silt loam, underlain by a mottled red heavy clay to a depth of about 2½ feet, where it rests upon a gray, sandy clay, mottled with red, which continues to greater depths. The soil contains a fair amount of humus, works up easily, and does not clod badly. The type is confined to rolling uplands with perfect drainage. It is derived from the heavy clay at the base of the Lafayette formation. Ironstone fragments are found to a limited extent in both soil and subsoil. The type is largely under cultivation. Corn, cotton, and oats are the principal crops, though Bermuda grass should do well.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Sassafras silt loam	Delaware 1; Maryland 1, 2, 3, 4, 5, 6, 8, 9; New Jersey 1, 3; Pennsylvania 6, 17.	518,142
Crowley silt loam	Arkansas 4, 5; Louisiana 1	477,120
Monroe silt loam	Louisiana 12, 13; Mississippi 16	300,992
Acadia silt loam	Arkansas 4; Louisiana 1	225,792
Portsmouth silt loam	North Carolina 6, 20; Virginia 10	181,760
Elkton silt loam	Delaware 1; Maryland 1, 3, 4, 5, 6, 8, 10; New Jersey 1; Pennsylvania 6.	168,468
Lufkin silt loam	Mississippi 3, 12, 15, 16; Texas 10	72,832
Hammond silt loam	Louisiana 13	70,976
Norfolk silt loam	Alabama 22; Mississippi 9, 10, 14; North Carolina 15, 20; South Carolina 7; Virginia 5.	67,840
Pheba silt loam	Mississippi 3, 14, 15	47,040
Landry silt loam	Louisiana 1	37,696
Susquehanna silt loam	Mississippi 5, 9, 15	29,952
Oktibbeha silt loam	Mississippi 10, 12	23,168
Scranton silt loam	Mississippi 18	18,112
Ruston silt loam	Mississippi 9, 10	17,728
Coxville silt loam	North Carolina 21; South Carolina 7	17,408
Hyde silt loam	North Carolina 16	8,000
Berzelia silt loam	Georgia 5	832
Mattamuskeet silt loam	North Carolina 16	704
Total		2,284,562

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

The clay loams of the Atlantic and Gulf Coastal Plains are adapted only to certain of the general farm crops. They are too stiff in structure and too late in maturing crops for profitable utilization in the production of even special-purpose vegetables. The range of adaptation to general farm crops is more restricted than in case of the silt loams. Wheat, oats, and rice do well, and heavy yields of forage crops, such as sorghum and cowpeas, or mixtures of these with corn, are secured. Grass does well, but owing to the restriction of grazing to dry-weather conditions on account of the tendency of such heavy soils to become compact when trampled under wet conditions, profitable stock raising and dairying must depend less upon pasturage than in case of the lighter soils and must be supplemented with heavy crops of forage for ensilage and soiling.

Good yields of corn are secured under normal conditions of weather and where frequent thorough cultivation is given the crops. The profitableness of cotton farming on these soils depends to a large extent upon the selection of early varieties. Where the boll weevil is troublesome the very earliest maturing varieties must be grown, and even with these full crops may not always be had. The soils of this group require a heavy farm equipment. Fall plowing usually improves the structure.

The clay loams of the Coastal Plains have their most important development in the Fatwoods and Coastal Prairie regions and in those sections underlain by calcareous formations. The Coxville and Portsmouth clay loams have a moderate development in the Flatwoods. The Greenville clay loam occurs as an important soil in southwest Georgia, western Florida, and portions of Alabama, and has a rather patchy development through the inner division of the province, especially in Alabama, Mississippi, and Georgia. In the black prairie belt of Alabama and Mississippi there are considerable bodies of the Oktibbeha clay loam. In Texas the Wilson, Crockett, Houston, and Grayson clay loams are important soils in the central, north-central, and western portions of the province. Scattered patches of Susquehanna clay loam are encountered in eastern Texas, Mississippi, Alabama, and Maryland.

Bladen clay loam.—The soil is a grayish, heavy, compact fine sandy loam to loam underlain at depths of 2 to 4 inches by slightly heavier material. The subsoil, beginning at a depth of 5 or 6 inches, is a mottled grayish and yellow fine sandy clay which quickly grades into plastic clay similarly mottled and occasionally showing shades of brown. The surface is mainly flat and the drainage poor. With the establishment of proper drainage the shallow-rooted crops, such as oats and grass, would give best results.

Coxville clay loam.—The soil consists of a dark-gray to black, plastic clay loam from 4 to 8 inches deep. The subsoil is a grayish, stiff, plastic clay mottled with brick-red, drab, and other colors. It occupies flat to slightly depressed areas having poor drainage. Where well drained this soil would produce good yields of oats and corn.

Crockett clay loam.—This is a dark-brown or black clay loam from 12 to 18 inches deep, underlain by a mottled drab and red, and sometimes yellow, clay loam. Both soil and subsoil contain a small proportion of fine, smooth gravel or iron concretions. At a depth of several feet a brittle gray material, which has much the same texture as soft soapstone rock and which is sometimes stratified, is encountered. The surface is gently rolling to level, and the type is fairly well drained. This soil owes its origin to the weathering of some calcareous material, perhaps an impure limestone. It is best suited to cotton, corn, grain, and grasses. Alfalfa also should do well.

Edna clay loam.—This soil to a depth of 12 inches consists of a gray to dark-gray, heavy clay loam, overlying a mottled gray and yellow clay subsoil. It is formed by weathering of noncalcareous clay deposits of Pleistocene age. The surface is level to gently undulating and drainage is poor. The type is used principally for rice, to which it is well adapted. Corn and cotton are grown to some extent with fair yields.

Grayson clay loam.—This soil consists of a dark-gray or brown clay loam from 8 to 10 inches deep underlain to a depth of 3 feet by a stiff, yellow and sometimes mottled clay or silt clay. The soil contains some alkali, but only in small spots. Gypsum crystals are also scattered through the type. The type covers an area resembling an old lake bed, with occasional spots containing considerable sand. The surface is flat or broken by small knolls or ridges. Practically all of the type is unfit for agriculture, mainly on account of the lack of drainage. Occasional small elevated areas are cultivated, but crops frequently fail during wet years.

Greenville clay loam.—The surface soil is a dark-brown to reddish-brown heavy sandy loam to clay loam from 3 to 5 inches deep. The subsoil is a deep red sandy clay. The material is derived mainly from the Lafayette formation. Under cultivation it resembles a clay loam, requiring careful handling for the maintenance of a good structural condition. The clay subsoil has been exposed through the action of erosion, leaving gall spots, which are generally covered on the surface with small iron concretions. The topography is generally undulating, with some flat and gently rolling areas. Erosion is most noticeable over the rolling areas. The surface drainage over most of the type is excellent. It is highly adapted to cotton, which under ordinary methods of cultivation yields from one-half to 1 bale per acre, but which should produce 1 to 2 bales with proper management. Corn, oats, and forage crops do well.

Houston clay loam.—The soil is a heavy grayish-brown loam or clay loam, from 8 to 15 inches deep. The subsoil has the same texture, but the color changes gradually from brownish-gray to yellowish at a depth of 4 or 5 feet. Small rock fragments often occur in both soil and subsoil, but where the development is typical the underlying rock is found at a great depth, and no fragments are encountered. The type is of residual origin, derived from white limestone or chalk. It occupies gently rolling prairies and is well drained. It is a good soil for cotton, corn, and sorghum, and under irrigation is well adapted to truck farming and such fruits as can be grown in the region.

Lacasine clay loam.—The soil is a brown or black heavy clay loam, 20 inches deep, grading into a mottled clay subsoil, which contains some silt, iron nodules, and occasional lime concretions. The type occupies depressions in large swamp areas free from hummocks. It is heavy, difficult to till, and poorly drained, but has lasting properties. It is considered of no agricultural importance.

Maverick clay loam.—The soil consists of 8 to 10 inches of ashy gray to light brown clay loam, with a high content of lime. The surface inch or two usually contain a considerable amount of sand, forming a very shallow covering over the thin, baked crust. The subsoil is similar in texture to the soil, but becomes heavier, more compact, and slightly lighter in color with depth, grading at 25 to 30 inches into a light yellowish brown or drab clay. The topography is level to gently rolling. The soil has a tendency to become hard and baked in dry weather, and during droughts the crops grown without irrigation either prove a failure or produce small yields. Under irrigation the soil is very productive.

Norfolk clay loam.—The soil consists of a dark-brown clay loam, about 6 inches deep, underlain by a dense, waxy clay of a dark reddish brown color. At about 24 inches thin lenses of very fine sand are encountered and the color

changes to a mottled grayish blue. The surface is flat and the elevation only about 10 feet above sea level. Much of the type is imperfectly drained. It is best adapted to grass and small grains, and formerly produced large yields of wheat. At present the yield of this crop rarely exceeds 10 bushels per acre.

Oktibbeha clay loam.—The soil is from 4 to 6 inches deep and consists of a dark-brownish, friable fine loam or heavy silt loam, usually containing a fair amount of humus. The subsoil is a yellowish-brown silty clay, sometimes mottled with gray and red to a depth of 30 to 36 inches. The topography is sufficiently rolling to permit of good drainage. Some of the slopes should be protected from erosion. The type is derived from a thin layer of silty clay immediately overlying the heavy lignitic clay. The typical timber growth consists of oak, hickory, and pine. About half the type is under cultivation. Cotton, wheat, and oats are the principal crops. It is an excellent cotton soil.

Portsmouth clay loam.—The soil is an ashy-gray to dark-brown clay loam about 6 inches deep. It grades abruptly into a dense waxy clay which extends to a depth of 24 inches. The subsoil below this depth contains pockets of thin sand. The soil occupies flat or trough-like depressions along tidewater, and the drainage is imperfectly established. It is derived from marine deposits. The type is used for the production of corn, wheat, and grass, of which moderate yields are secured.

Susquehanna clay loam.—The soil is a yellow or brown loam about 10 inches deep, underlain by a mottled red heavy clay identical with the Susquehanna clay. The type occupies hills, slopes, and valleys, and is adapted to grain and grass crops. Considerable areas are yet in oak and pine forest.

Wilson clay loam.—The type consists of 6 to 10 inches of a dark-brown to black clay loam underlain by a compact and tenacious clay which becomes heavier in texture and lighter in color with depth, and at 36 inches is frequently streaked with yellow. It is an upland type, and occupies gently rolling, gradual slopes. Drainage is usually well established. The soil is derived from the weathering of sedimentary deposits of Eocene or Tertiary age. It is locally known as "mesquite flats" and but little is under cultivation, although cotton, corn, oats, and sorghum do well in favorable seasons. The soil is rather difficult to handle.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Houston clay loam	Texas 11, 12, 27, 28	1,313,536
Maverick clay loam	Texas 28	898,560
Greenville clay loam	Alabama 1, 5, 9, 12, 13, 25, 34; Georgia 15; Mississippi 8, 12, 15, 16; South Carolina 6, 16; Texas 1, 14, 15, 18, 21, 23.	369,024
Wilson clay loam	Texas 3, 9, 10, 11, 24, 29	96,768
Edna clay loam	Texas 12	73,728
Oktibbeha clay loam	Alabama 1; Mississippi 3, 12, 15	48,960
Susquehanna clay loam	Louisiana 5; Maryland 1, 8	31,826
Portsmouth clay loam	Georgia 10; Mississippi 18; North Carolina 25; Virginia 12	22,144
Coxville clay loam	Georgia 2; North Carolina 25; South Carolina 10	22,144
Crockett clay loam	Texas 3, 14, 24	21,440
Bladen clay loam	Georgia 10	19,776
Grayson clay loam	Texas 11	10,560
Lacasine clay loam	Louisiana 8	3,470
Norfolk clay loam	Virginia 12	1,856
Total		2,933,792

[1] For key to numbers in this column see p. 733.

GRAVELLY CLAY LOAM PHASE.

The gravelly clay loam phase is of relatively little importance in the Coastal Plains in point of extent, only one type having been recognized—the Greenville gravelly clay loam. It has a slightly lower value than the clay loam of the series and is considerably more difficult to plow. Gravelly clay loams when dry are often difficult to cultivate and keep in a good condition of tilth, and for this reason yields are generally inferior to those obtained from the more easily worked clay loams.

Greenville gravelly clay loam.—The soil to a depth of 4 or 5 inches consists of a reddish-brown, heavy, sandy loam with sufficient clay to impart the working qualities of a friable clay loam. In places the texture is decidedly a clay

loam. The subsoil is a reddish or dark-red sandy clay which frequently becomes heavier with depth. Iron concretions are abundant over the surface, through the soil, and to a lesser extent in the subsoil. The surface ranges from undulating to gently rolling, being well suited to good surface drainage without danger of destructive erosion. The soil is sometimes difficult to keep in good structural condition unless the organic matter content is carefully maintained by the occasional incorporation of vegetable matter. Cotton, corn, oats, rye, and forage crops give very good results.

Area and distribution of the gravelly clay loam.

Soil name.	State or area.[1]	Acres.
Greenville gravelly clay loam	Georgia 15	5,760

[1] For key to number in this column see p. 733.

SILTY CLAY LOAM PHASE.

San Antonio silty clay loam.—The San Antonio silty clay loam consists of 6 to 10 inches of a dark-brown to black silty clay loam with a decidedly reddish tinge. The color ranges from reddish brown to brownish red, and the texture from a heavy loam to clay loam with a high percentage of silt. If plowed when dry, the soil works up into a mellow, loamy condition, but the proportion of clay present is always sufficient to make it plastic and sticky when wet. The topography is level. The soil contains lime and organic matter and is highly productive.

Webb silty clay loam.—The soil consists of a brown to reddish-brown silty clay loam or clay to an average depth of 8 to 10 inches. Upon drying it becomes baked and sun-cracked, and a thin, light-brown crust forms on the surface. The subsoil consists of a brown to reddish-brown, heavy clay, slightly lighter in color than the surface soil. Small particles of gypsum are of common occurrence in both soil and subsoil and are especially numerous at depths below 24 inches.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
San Antonio silty clay loam	Texas 28	398,592
Webb silty clay loam	do	34,560
Total		433,152

[1] For key to number in this column see p. 733.

CLAY GROUP.

The clay soils of the Atlantic and Gulf Coastal Plains are adapted to the production of heavy special farm crops, such as mixtures of corn, sorghum, millet, or other of the coarser forage crops for ensilage or dry winter feed. Wheat, rice, and grass do well. Cultivation is so difficult and is limited to such a narrow range of moisture conditions that the production of corn as a grain crop is not profitable. The early maturing varieties of cotton, under intensive cultivation and outside of boll-weevil infested districts, give fairly profitable returns, although somewhat lower than those obtained from the clay loams. Complete failures may be expected occasionally when the crop is grown in sections infested by the weevil.

Grazing is restricted to even narrower limits than on the clay loams, owing to rapid deterioration of the sod when trampled or closely grazed for any considerable time. Successful stock raising and dairying on the clays, therefore, depends mainly upon the production of heavy crops of ensilage, coarse forage, and hay.

The heaviest farm equipment is required to bring out the highest efficiency of these soils, and it is because of the lack of adequate equipment throughout the province and the relatively small area covered by the soils of this group that

they have, except in case of such calcareous clays as the Houston, generally been held in low esteem and often entirely neglected.

Liberal applications of lime and fall plowing are generally beneficial in improving the structural condition of the noncalcareous types.

The clays comprise a very important group of soils in the Flatwoods and Coastal Prairies, in the limestone regions of the Coastal Plains, and the sections where the Susquehanna soils are prominently developed.

The Coxville and Portsmouth clays are scattered in small areas throughout the Flatwoods, especially in Georgia and the Carolinas, while the Victoria and Lomalto clays have been extensively mapped in the Coastal Prairie section of Texas. The Houston clay is the most extensive and important soil in the "black belt" of central Alabama, northeastern Mississippi, and central and western Texas. In the "black belt" of Alabama and Mississippi the Oktibbeha clay is an important soil, while the Wilson clay is a fairly prominent type in central and western Texas. The Susquehanna and Lufkin are the most important types of eastern Texas and Mississippi outside of the Houston areas. The Susquehanna clay has a fairly extensive development throughout the inner division of the Coastal Plain in Alabama and western Georgia and in the North Atlantic division, especially near the Piedmont border.

Alloway clay.—The type is a red or gray clay loam 6 inches deep, containing some gravel and underlain to a depth of 3 feet or more by a mottled yellow and gray sticky clay. The type occupies rolling upland depressions or bottoms, and is derived from recent sediments of Miocene or Glacial material. It is a good grass and wheat soil and produces a good grade of apples. The soil is difficult to till, and generally requires underdrainage.

Bladen clay.—The soil to a depth of 2 to 5 inches consists of a grayish or black heavy clay loam. The subsoil is a plastic, heavy clay with mottlings of yellow and brown in the upper section, and of blue, brown, and yellow in the lower part. Drab and gray colors are also frequently noticeable throughout the subsoil. The type occupies flat depressions of apparently recent tidal marsh. Drainage is usually poor, and the soil is difficult to work, the type being of little agricultural value except for rice. With artificial drainage and liming it would probably produce fair crops of corn, oats, hay, and sugar cane.

Coxville clay.—The soil consists of a dark-gray to black fine sandy loam to loam, averaging about 4 inches in depth. The loam phase is usually darker in color and is confined largely to the slight depressions. The subsoil is a drab plastic clay with yellow and red mottlings. The plasticity increases and the red mottling becomes more pronounced with depth. The type occurs as flat "savanna" lands. It has poor surface drainage and remains saturated the greater part of the year. During periods of drought the surface bakes and cracks. Very little of the type is under cultivation. If provided with good surface drainage by ditching, plowed deep, limed, and well supplied with organic matter, good crops of cotton, oats, corn, and strawberries could be grown. Plowing must be done when the soil is in proper moisture condition, for if plowed when too wet it is likely to clod badly.

Durant clay.—This soil is a dark brown to almost black clay, 9 inches deep, sometimes having a dark-bluish color. Lime concretions or gravel are scattered over the surface and throughout both soil and subsoil. The type is derived from marly clays of the Eagle Ford formation. The topography varies from level to gently rolling. Cotton yields one-third to three-quarters of a bale, corn 30 to 40 bushels, and oats 40 to 50 bushels per acre.

Ellis clay.—This soil to a depth of 6 inches consists of a yellowish-brown clay having a peculiar dark green cast. The subsoil is a heavy plastic clay to a depth of 3 feet or more. In many places fragments of hard brown limestone are scattered over the surface and occur throughout the soil and subsoil. The soil is very sticky and plastic when wet and bakes hard on drying. The surface varies from rolling to hilly and even broken. The broken areas are badly eroded. The type is derived from the marly clays of the Eagle Ford formation and from the Taylor marl. Because of the difficulty of cultivation and hilly surface the greater part of the type is unused. It is better suited to cotton than any other crop and yields from one-quarter to one-half bale per acre.

The proper place for this soil in the key to the Coastal Plains province is under the heading "Calcareous material," attached to the "Drainage well established" leg, as follows: Yellowish-brown soil—yellow subsoil—derived from marly clays—surface hilly.

Greenville clay.—This type consists of less than 6 inches of red or chocolate-red clay or heavy clay loam, resting upon a red or yellowish-brown to reddish-

yellow, very heavy, stiff, tenacious clay. The type occupies ridges and knolls and is residual in origin. Rock outcrops are common where the type is underlain by limestone. Weathered fragments of varying size frequently occur on the surface. This is recognized as a strong soil for general agriculture, but it is very difficult to cultivate.

Houston clay.—The soil is a gray to brown loamy clay, 4 to 10 inches deep, resting upon a stiff, lighter colored clay subsoil, which grades at a depth of about 20 inches into a light-gray or white rotten limestone or chalk. The color of the soil varies somewhat, according to topographic position, the darker colored areas occupying the depressions and more level situations, while the white subsoil is often exposed along slopes, giving rise to irregular spots resembling "galls." The soil is friable and easily cultivated under proper moisture conditions, but is extremely plastic and sticky when wet. Areas not under cultivation bake and check on drying. The type occupies level to gently rolling country, usually prairie, and is derived from rotten limestone or chalks of Cretaceous age. Cotton is the principal product, although good yields of corn, oats, grass, and legumes are secured.

Hyde clay.—The soil to a depth of 2 to 5 inches consists of a black, heavy clay loam, plastic when wet and tending to crack upon drying. The subsoil is a black, plastic, tenacious clay, the lower portion having a bluish cast. The type is characteristically developed between slight ridges of lighter colored soils. It occupies depressions and has a flat surface and impervious subsoil. The drainage is naturally poor. Plowing is difficult, owing to the proximity of the unwieldy subsoil. With drainage and liming fair to good crops of corn, oats, onions, cabbage, strawberries, cauliflower, and celery can be secured.

Lomalto clay.—The type consists of 12 to 15 inches of dark-drab to black clay or silty clay, which passes rapidly into a light-brown to reddish-brown silty clay subsoil. The soil puddles and bakes badly. Beds of crystalline gypsum and lime concretions occur in the subsoil. The surface is nearly level and low lying, so that overflows are frequent. It is an alluvial soil formed under marshy conditions. A large quantity of alkali is present in both soil and subsoil, and drainage facilities are so poor as to make the reclamation of the land for agriculture difficult.

Lufkin clay.—The soil is a loam or silty loam, from 3 to 8 inches deep, occasionally containing a few iron concretions. The subsoil is a drab or mottled gray and yellow, stiff, impervious clay. At a depth of 3 to 5 feet the clay is often distinctly stratified. The surface is generally level and drainage is poor. The natural timber growth consists of scrub pine and small oaks. The soil is not well adapted to ordinary farm crops, and only small yields of corn and cotton are obtained.

Montrose clay.—This type consists of a grayish-drab clay, with a depth of 2 to 6 inches, underlain by a yellow or yellow and gray, very plastic clay, which shows mottlings of red and yellow below 20 inches. The subsoil is very heavy and has a somewhat greasy feel when wet. In places the surface is covered by an inch or two of sandy loam. The type occupies flat, poorly drained areas, and is locally known as "hog wallow prairie." On account of its low humus and high clay content it is difficult to cultivate. It is derived from the Jackson formation of Eocene age. The type is almost all timbered with scrawny post and blackjack oak. Some shortleaf pine also occurs.

Morse clay.—This type consists of a heavy silt or clay loam 6 to 8 inches deep, underlain by a heavy mottled clay subsoil, both soil and subsoil being quite calcareous. It occurs along stream courses, and generally has good drainage. The type is unimportant, difficult to till, and but little of it is under cultivation. It is adapted to rice where irrigation is possible, and in the well-drained areas is fairly well adapted to corn and cotton.

Oktibbeha clay.—This type consists of a heavy, yellowish-brown sandy clay, 3 feet or more in depth, beyond which the material becomes mottled. There are several phases of the type. The topography is sloping or rolling and the heavy soil does not permit rapid absorption of rainfall, consequently the run-off is excessive and erosion very active. The type is largely the result of wash in areas which were once Oktibbeha fine sandy loam, the fine sand having been removed. Most of it has been cleared, but very little is now under cultivation. It is largely devoted to pasture or allowed to grow up in scrub pine, oak, or wild plum. Cotton is the principal crop, but yields are comparatively light.

Pheba clay.—The soil consists of a light brown clay or silty clay averaging about 8 inches in depth, with an occasional shallow mantle of fine sandy material. The subsoil is a brownish or yellowish, rather plastic clay, mottled in the

lower section with gray. The surface drainage of the flat areas is frequently poor. The type is usually deficient in organic matter and is inclined to bake unless liberally supplied with vegetable matter. Applications of lime are also necessary to bring about a good tilth. The type is best adapted to wheat, grass, and forage crops, while cotton, corn, and oats give fairly good results.

Point Isabel clay.—The soil is a drab to brown heavy clay from 10 to 15 inches deep. The subsoil is lighter colored, but of the same texture as the soil. The material does not bake badly. The type occupies long, narrow ridges or beaches, the tops of which are narrow and level and the slopes steep and abrupt, allowing excessive drainage. These beaches were formed by wave action where salt water occupies the basins below. The type is of little agricultural value.

Portsmouth clay.—The soil is a dark gray to black silty loam to clay loam ranging in depth from a few inches to nearly 8 inches. The soil material is usually heavier and more compact in the higher, better drained situations. In the wet or swampy areas the soil is generally a dark gray to black, smooth silty loam, from 10 to 14 inches deep. The subsoil is a stiff, impervious clay mottled with gray and yellow, or drab, yellow, and reddish yellow. The type occurs on poorly drained flat uplands and in drainage ways or other depressions. It is derived from the Columbia sediments. The typical vegetation consists of bay, scrubby sweet gum, gallberry bushes, and pine. Heavy applications of lime are necessary to secure best results with crops. On well-drained areas corn, forage crops, and oats are produced with success.

Sumter clay.—The soil to a depth of 4 or 5 inches is a yellowish-brown clay loam to clay. The subsoil is a sticky, plastic clay of yellow color, sometimes showing a greenish cast. Small particles and fragments of gray to white limestone occur in the subsoil. As a rule both soil and subsoil are decidedly calcareous. In spots the soil color is almost black, such areas resembling the Houston clay. The subsoil seems to be more plastic and impervious than that of the Houston clay and the drainage not quite so good. With more complete weathering this soil might give rise to the Houston clay. The topography is flat to gently rolling. It is derived from limestone and calcareous clays or clay shales belonging to the Vicksburg or possibly the Vicksburg and Jackson formations. It is a strong soil, well suited to the general farm crops. Corn, cotton, and oats do well. Alfalfa has been successfully grown, and with careful soil preparation and seeding it is believed the crop can be made a profitable one on the smoother areas. Melilotus gives good results. When plowed under proper moisture conditions a good friable seed bed is easily secured. The type does not have the gray soil color and red mottling in the subsoil which seem to constitute the important characteristics of the Montrose.

Susquehanna clay.—The soil is a clay loam 6 inches deep, sometimes containing gravel, and overlying a stiff, tenacious, red and mottled pipe-clay subsoil. The type occupies hills and rolling areas on the inner border of the Coastal Plain region. The soil is very refractory and hard to cultivate and at present has very little agricultural value.

Victoria clay.—The soil to an average depth of 10 inches consists of a dark brown to black clay loam, and is underlain by a compact, calcareous clay loam or clay, lighter in color than the soil and often containing small lime concretions. At depths ranging from 2 to 5 feet the subsoil usually becomes slate colored. When dry the soil of uncultivated fields bakes and checks, and when wet it becomes sticky and tenacious. The type is of residual origin, and is derived from calcareous clays of Tertiary age. The surface is level to gently undulating, and drainage is fair. With careful cultivation the general farm crops give good results.

Webb clay.—The soil to a depth of 10 to 12 inches consists of a dark reddish brown to purplish-red clay loam or clay. The surface 2 or 3 inches often contain an appreciable amount of sand, causing it to be slightly loamy, but in general it is very sticky and tenacious when wet and bakes and cracks upon drying. The subsoil is a calcareous clay which becomes lighter in color with depth and at 3 feet or more consists of a compact, stiff clay having a very light reddish brown or slightly pinkish color. It has been formed from a red calcareous clay, modified slightly in some cases by alluvial depositions from smaller streams. The topography is level to gently rolling with low ridges and valleys. At present none of the type is under cultivation. Where moisture conditions are favorable it should prove a strong soil, but in its present condition it is best left in pasture, to which it is well suited.

Wilson clay.—The surface soil of this type consists of 10 to 15 inches of very heavy clay, varying in color from a dull-yellow to dark-brown or almost

black. The subsoil is very similar to the soil in texture, but somewhat more tenacious and lighter in color, owing to a diminished content of organic matter. Partially decomposed lime concretions are found scattered through the soil and subsoil, being more numerous in the latter. The intermingling of dull yellow and darker colored soil in fields of Wilson clay is very noticeable along the slopes where the fields appear to be striped alternately from yellow to dark, the stripes extending up and down the slopes. It is very plastic when wet, but cracks badly in dry seasons. The topography varies from rolling to level. The drainage, in seasons of normal rainfall, is good. The type is adapted to cotton, corn, and grain and seems especially adapted to oats.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Victoria clay	Texas 12, 27, 28	2,128,896
Houston clay	Alabama 1, 5, 13, 17, 25, 30, 31, 34; Louisiana 14; Mississippi 3, 8, 10, 12, 14, 15, 16, 17, 20; Texas 2, 9, 10, 11, 26, 28, 31.	891,624
Lomalto clay	Texas 12, 27	525,824
Susquehanna clay	Alabama 2, 3, 5, 14, 18, 25, 30, 32; Louisiana 2, 3, 9, 14; Maryland 3, 5, 8; Mississippi 8, 9, 10, 14, 15, 20; Texas 10, 11, 13, 14, 20, 29.	483,882
Lufkin clay	Alabama 34; Louisiana 3, 12; Mississippi 3, 4, 12, 14, 15, 16; Texas 1, 7, 13, 14, 19, 21, 23, 24, 34.	392,256
Oktibbeha clay	Alabama 17; Mississippi 3, 10, 12, 14, 15, 17	214,464
Wilson clay	Texas 11	100,864
Portsmouth clay	Georgia 10, 15; North Carolina 21; South Carolina 6, 10	52,736
Montrose clay	Mississippi 8	43,840
Durant clay	Texas 9	39,936
Pheba clay	Mississippi 14	35,200
Webb clay	Texas 27	23,040
Alloway clay	New Jersey 1, 3	22,484
Ellis clay	Texas 9	18,880
Coxville clay	Georgia 3; South Carolina 7, 10	17,280
Morse clay	Arkansas 4; Louisiana 1	7,424
Sumter clay	Mississippi 20	6,016
Hyde clay	Georgia 3, 10	5,376
Point Isabel clay	Texas 5	4,096
Bladen clay	Georgia 3	3,648
Greenville clay	Florida 7	768
Total		5,018,534

[1] For key to numbers in this column see p. 733.

BLACK CLAY PHASE.

While treated as a variation from the typical clays, the black clay phase is, nevertheless, a very important adjunct to the clay group. It is represented by a single soil type, which occurs extensively in Texas, as well as in Alabama and Oklahoma.

Houston black clay.—The soil is a black or sometimes drab clay about 10 inches deep, friable when well cultivated, but waxy and sticky when wet. If not continuously cultivated, it becomes hard and compact and cracks into irregular blocks on drying. The subsoil is a waxy, very stiff and tenacious clay of lighter color than the soil. Both soil and subsoil contain varying quantities of lime concretions. The type is derived from the weathering of soft limestone or calcareous clays, principally of Cretaceous age. The soil is very productive, and is used commonly for corn, cotton, and rice, according to locality, elevation, and drainage. It is also adapted to grass.

Area and distribution of the black clay.

Soil name.	State or area.[1]	Acres.
Houston black clay	Alabama 34; Oklahoma 2; Texas 1, 2, 3, 7, 9, 11, 14, 17, 18, 23, 26, 28, 31, 32.	1,509,080

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

The stony clay soils occupy steep slopes, the backbones of narrow, eroded ridges, and washed areas underlain by rock. Usually the topography is sufficiently rough to preclude agricultural use, aside from the number of stone fragments present. The smoother areas are largely worthless on account of the abundance of stone. These soils are confined mainly to those areas of the Coastal Plain underlain by limestone and to the Claiborne formation in southwestern Alabama and east-central Mississippi.

Henderson stony clay.—This type consists of a greenish-gray, sticky clay carrying large quantities of limestone fragments in various stages of decomposition. There is usually a thin mantle of fine sand over the surface of the less stony areas. The soil is derived from exposures of Tertiary limestone. None of this type has been seen under cultivation, and the soil would probably prove of very low agricultural value on account of the intractable character of the material.

Houston stony clay.—This soil consists of 4 to 15 inches of dark-brown or black clay, which is underlain by white chalky limestone, with limestone fragments of various sizes scattered over the surface. The type is derived from the weathering of Austin chalk. It is easily eroded, and small areas, where the underlying limestone outcrops, frequently occur on the hillsides and on the summits of rounded knolls. Owing to the shallow soil, the type does not stand drought well. The yields on this type depend largely upon season. When moisture conditions are favorable, good yields of cotton, corn, wheat, and oats are secured.

Lauderdale stony clay.—The type consists of a yellow to nearly white stiff clay, carrying on the surface and throughout the soil section from 25 to 60 per cent of stone fragments, consisting of rather soft siliceous rock of white to yellowish or mottled reddish and gray color, and to a less extent of reddish, locally cemented sandstone and a hard siliceous rock resembling quartzite. There is no distinct line of demarcation between soil and subsoil. The type is locally styled "white hills" and "white rock land" and occupies the crests of narrow, high, winding ridges and the tops of hills with occasional developments on the lower slopes. The soil is derived from the Claiborne-Tallahatta buhrstone formation. The topography is so rough as to render the type unfit for profitable agriculture and it is valued chiefly for its timber.

Sumter stony clay.—This is a yellowish-brown clay loam to clay, underlain at 8 inches by a pale-yellow to gray, plastic, heavy clay. Gray limestone fragments are scattered over the surface and disseminated through the soil mass in quantities sufficiently large to interfere with cultivation. The type occupies slopes and knolls, and the underlying limestone outcrops in places. It is derived mainly from limestone. The soil is productive and adapted to cotton, corn, cowpeas, oats, and melilotus.

Area and distribution of the stony clays.

Soil name.	State or area.[1]	Acres.
Houston stony clay	Texas 9	78,336
Lauderdale stony clay	Mississippi 9	23,488
Sumter stony clay	Mississippi 20	2,432
Henderson stony clay	Alabama 32	192
Total		104,448

[1] For key to numbers in this column see p. 733.

GRAVELLY CLAY PHASE.

The gravelly clay phase is represented in this province by one soil type, the Houston gravelly clay, which has been mapped so far only in Texas, where it has been found in several different areas.

Houston gravelly clay.—The soil is a dark-brown to black heavy clay loam or clay 12 inches deep, carrying a large amount of gravel and rounded, waterworn pebbles varying in size from one-eighth of an inch to 3 inches in diameter. The subsoil is a light-brown, stiff clay, becoming less flexible with depth and carrying small quantities of rounded gravel and pebbles. Small areas occur where the soil mass is a bed of porous gravel. The type occupies the higher

ridges of rolling prairie and is easily eroded. The gravel is derived from the remains of an old formation, which has been almost entirely worn away, leaving only a thin layer capping the higher ridges. Owing to its topography and gravelly character, the type has good drainage. The crops grown are cotton, corn, sorghum, oats, and some kafir. Good yields are usually obtained.

Area and distribution of the gravelly clay.

Soil name.	State or area.[1]	Acres.
Houston gravelly clay	Texas 2, 3, 26, 31	94,720

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

San Antonio silty clay.—The soil consists of a brown to reddish-brown clay loam from 10 to 12 inches deep. This grades into a heavy silty clay subsoil, the red color becoming more pronounced and the material heavier with depth. A few small, chalky particles of thoroughly disintegrated limestone are encountered in the lower subsoil, and beds of rounded gravel cemented with a reddish, marly material sometimes occur at a depth of 5 feet or more. The type occupies gently undulating to almost level areas. It is largely composed of material transported by floods in early times and laid down along stream courses. In part, however, it is derived from the decomposition of underlying limestone. The soil is considered excellent for general farming and makes a valuable truck soil. Considerable areas are under irrigation and devoted largely to the production of onions. Other vegetables, as well as cotton, corn, potatoes, alfalfa, peanuts, and oats, are grown both on irrigated and unirrigated areas.

Area and distribution of the silty clay.

Soil name.	State or area.[1]	Acres.
San Antonio silty clay	Texas 26	18,048

[1] For key to number in this column see p. 733.

MISCELLANEOUS MATERIAL.

The materials included under this heading are not, in their original state, arable soils, and a part of them can not be made fit for cultivation. Some, however, by extensive and costly reclamation work can be made to produce more or less bountiful crops. This will be indicated specifically in the following paragraphs.

Chalk (Houston).—This type includes exposures of the Selma chalk formation in badly eroded areas, where little or no soil has accumulated. The surface few inches varies from the bare, partially weathered white chalk to a light-gray or gray chalky loam, depending upon the stage of erosion. Below this is a white or yellowish-white, partially weathered chalk, which usually extends to a depth of 3 feet or more. Occasional outcrops of blue rock occur. The land is mainly valuable for pasture.

Coastal beach.—This is a light-gray or white, fine to coarse textured, loose, incoherent sand 3 feet or more in depth, containing varying quantities of shell fragments. It occurs as beaches, narrow ridges, and islands along the seacoast, and its surface varies from smooth to irregular. At the higher elevations it is modified by wind action. It is not adapted to agriculture.

Muck.—This type consists of black, more or less thoroughly decomposed vegetable mold, from 1 to 3 or more feet in depth. It occupies low, moist places, with little or no natural drainage. Muck may be considered an advanced stage of Peat, formed by the more complete decomposition of the vegetable fiber and the addition of mineral matter through deposition by water or wind, resulting in a finer texture and closer structure. When drained, Muck is very productive

and well adapted to corn, potatoes, cabbage, onions, celery, peppermint, and similar crops.

Peat.—The type is composed of vegetable matter, consisting of roots, stems, fibers, moss, etc., in various stages of decomposition. It occurs as turf or bog, usually in low situations, and is always more or less saturated with water. It represents an advanced stage of swamp, with drainage partially established. When properly drained Peat becomes a valuable soil for special crops.

Rock outcrop.—This term is used to designate areas consisting of rock ridges, exposed rock outcrops, or accumulations of stone entirely unfit for cultivation and incapable of becoming agricultural land.

Rough stony land.—Under this heading have been classed areas so stony and broken as to be nonarable, although supporting forest growth and affording some pasturage. These areas frequently consist of steep mountain ridges, bluffs, or narrow strips extending through definite soil types. These areas differ from Rock outcrop in that they support vegetation of economic value, and from the stony loams in being nonarable.

Sandhill.—This term is used to describe ridged and uneven areas of sand not in motion, either on account of partial consolidation or because of the sand being fixed by a natural growth of trees or grasses. Such areas sometimes represent old shore lines of the oceans or large lakes and are sometimes formed by river action and by wind. The material is incoherent and is generally so thoroughly drained as to be of little agricultural value. Included valleys and low areas, where organic matter and sufficient moisture are present, are capable of producing fair crops of vegetables.

Swamp.—This term is used to designate areas too wet for cultivation and covered with standing water for much or all of the time. Variations in texture and in organic matter content may occur. Swamp frequently occupies areas which are inaccessible, so that detailed mapping is impossible. The native vegetable growth consists of water-loving grasses. shrubs, and trees. Many areas are capable of drainage, and when reclaimed they not infrequently constitute lands of high agricultural value. Wherever small areas of Swamp occur within a definite soil type and the texture of the soil is known to be similar to that of the surrounding type, they are mapped with the type and the swampy condition indicated by symbol.

Tidal marsh.—The material varies from dark, oozy sediments, interspersed with coarse marsh-grass roots, to a yellowish or dark-colored clay, and rests upon a still heavier clay at depths varying from 2 to 4 feet. Calcareous nodules are sometimes present. This material is extensively developed along the seacoast and along streams subject to tidal overflow. The vegetation consists of salt grass, which affords poor pasturage. The areas must be diked and drained before reclamation is possible, but when so reclaimed and the excess of salt removed the soil becomes exceedingly productive, especially for corn, cabbage, onions, rice, potatoes, and hay.

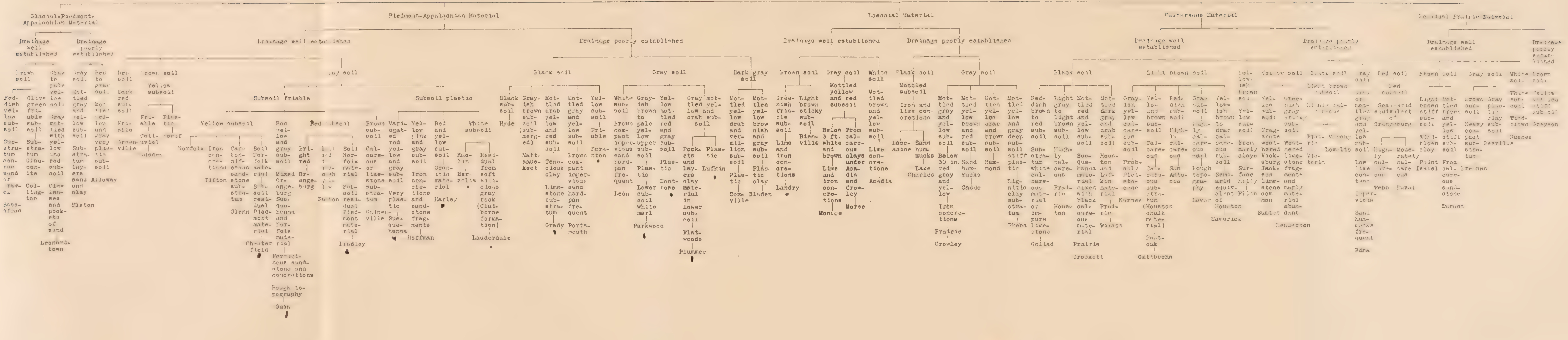
Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Gravelly soils undifferentiated	Texas 27	641,536
Tidal marsh	Alabama 2, 29; Delaware 1; Florida 4; Georgia 3, 10; Louisiana 10, 11; Maryland 1, 4, 10; Massachusetts 2; Mississippi 18; New York 7; North Carolina 19; South Carolina 4, 10; Virginia 12.	562,752
Coastal Beach	Alabama 2, 29; Delaware 1; Florida 1; Georgia 3, 10; Maryland 10; Massachusetts 2; New York 7; North Carolina 19; South Carolina 4, 10; Texas 12, 27; Virginia 10, 12.	322,496
Sandhill	Alabama 2; Florida 1, 5, 6; Georgia 17, 19; North Carolina 19, 22, 24; South Carolina 6, 7, 8, 10, 12, 14, 16; Texas 26.	157,448
Peat	Louisiana 13; North Carolina 16	78,800
Muck	Alabama 29; Florida 3; Georgia 2; Mississippi 18; North Carolina 16, 21, 22.	38,294
Chalk (Houston)	Alabama 1; Mississippi 3, 10, 12, 14, 15	25,024
Swamp	Louisiana 10	19,776
Rough stony land	Texas 20	832
Rock outcrop	Florida 7	384
Total		1,845,342

[1] For key to numbers in this column see p. 733.

Revision of September, 1912

Key to the Soils of the Atlantic and Gulf Coastal Plains Province



SOILS OF THE RIVER FLOOD PLAINS PROVINCE.

By Hugh H. Bennett.

DESCRIPTION OF THE PROVINCE.

BOUNDARIES.

The soils of the River Flood Plains province occupy the first bottoms and adjoining terraces of streams throughout that section of the United States lying east of the Great Plains Region, which is limited, roughly, by a line crossing the country from the Canadian boundary east of the Rocky Mountains through northern Montana, southwestern North Dakota, central South Dakota, eastern Nebraska, northeastern Kansas, central-western Missouri, eastern Oklahoma, and central and southwestern Texas. Some areas of flood-plain soil cover the bottoms and terraces of valleys which have been abandoned by their main streams.

These soils occur in continuous and interrupted strips along the banks of streams, their outer boundary being sharply marked ordinarily either by bluffs or steep slopes rising to the uplands. They vary from narrow strips a few feet wide along the minor drainage courses and those streams which pass through gorgelike valleys to broad bottoms several miles in width. The broadest strip of strictly alluvial land is that along the Mississippi River near its confluence with the Arkansas, where the bottoms range from 75 to 100 miles wide. The widest and most continuous bottoms are developed along the larger streams within the limits of the Atlantic and Gulf Coastal Plains, where the dominant soft, unconsolidated materials have been least resistant to the cutting back of the flanking bluffs by overflows, and where, owing to the relative low relief, the streams move slowly and tend to meander and spread over a wider area. In the regions of hard rocks and higher altitudes, such as the Piedmont Plateau and the Appalachian Mountains and Plateaus, the tendency of the streams has been to cut downward rather than outward, on account of the rapid current resulting from the steeper gradient and the hindrance offered to lateral planation by the resistant flanking rocks. Where the soils of the province occur in such regions they are developed as narrow, interrupted strips. In those sections occupied by the tougher, less soluble rocks, the streams flow through deep canyons, which are wholly without bottoms or terraces, but on entering regions of softer and more soluble rocks they have been much more effective in cutting away the retaining valley walls, and thus have developed the broader bottoms.

The stream bottoms of the glacial region, especially of the larger streams, are generally wider and more continuous than those of the Piedmont and Appalachian provinces. This is due to the lower relief and the softer character of the prevailing unconsolidated materials of the confining banks. The bottoms do not average so wide, however, as those of the Coastal Plains. This is attributable to a measurable degree, if not largely, to the fact that the glacial deposits are of more recent age than the main portion of the Atlantic and Gulf coastal deposits, the regional streams consequently having had less time to carry on their work of building flood plains.

TOPOGRAPHY.

The soils of this province include two topographic divisions: (1) The first bottoms or present flood plains, and (2) the terraces or old flood plains.

The first bottoms embrace the lowest lands of the province, those which are subject to submergence by overflow waters. Throughout this division the surface is dominantly flat and level. Occasional depressions, including abandoned channels and minor swales scooped out during overflows, together with slight swells and hummocks, consisting usually of sandy material, constitute the impor-

tant surface inequalities. Horizontally the bottoms are usually level or essentially so, but they frequently sink gradually away from the stream banks, being lowest along the outer margin, or they may rise with an imperceptible gradient toward the outer edges. Colluvial material from higher positions has been spread over the marginal border of some bottoms, frequently giving them a quite perceptible outward ascending slope.

The terraces, often styled "second bottoms" and "bench lands," include old flood plains which now stand largely above the influence of overflow water, the streams having cut their channels to lower levels, and flood plains have been built below these earlier plains now represented by terraces. Some streams have no overflowed bottoms at all, or only high bottoms subject to inundation only during periods of exceptionally high water. Here the channels have been cut sufficiently deep to carry all or nearly all flood waters within their immediate banks. In such cases the old flood plains, up to the immediate stream banks, have the essential characteristics of terraces—that is, they are not overflowed or are overflowed only by high freshets.

In their height above the first bottoms the terraces vary from a few feet to several hundred feet. There is often a series of distinct terraces arranged one above another in steplike succession. Some of those occupying the lower positions are subject to overflow during abnormal floods, but the soils of this division largely stand well above the highest overflows.

The surface features of the terraces vary from flat to rolling. Those occupying the lower levels are usually well preserved and ordinarily have smooth, flat surfaces, with distinct bluffs or sharp slopes marking both the inner and outer boundaries. The original configuration of many of the higher, older terraces is also well preserved, but this is true to a considerably less degree than in case of their lower and younger counterparts, long-continued erosion having effaced the original flat surface features of many of them. Large areas have been so deeply and minutely dissected that the terrace characteristics are distinguished only in perspective, the topography often being rolling or even hilly. But the most severely eroded areas generally have an even crest level and are bordered outwardly by escarpments or slopes reaching to the upland level of the highlands. In places erosion has obliterated the escarpment features of original bluffs which separated the terraces from the first bottoms on one side, and similar higher terraces (where these existed) on the other, and has worn down the outer or upland slope or bluff in such a way as to give the whole the general appearance of a continuous slope from the outer margins of the present flood plains to or nearly to the level of the uplands.

GEOLOGY.

The stream bottoms and terraces are made up of alluvial material, consisting of deposits washed from slopes and uplands and deposited downstream by overflow waters. This material varies in character from simple deposits derived from drainage basins comprising soils of uniform texture and character, laid down before the transporting water had been contaminated by water of other streams carrying in suspension material from different sources and of unlike character, to extremely heterogeneous deposits derived from drainage basins or several drainage basins including soils widely varient in texture and character.

The shape and size of the particles constituting the alluvium necessarily vary in some degree according to the distance transported. From the time the individual soil grains start on their water-borne journey they are subjected to alteration by attrition until deposited. Obviously those particles which have come to rest upon flood plains near their original position have not been as severely abraded and consequently not so worn down or rounded as those which have been carried farther downstream. With the lighter, finer particles, which have remained in suspension longest and have been transported farthest, this effect of attrition has been of little importance; it is upon the coarser material swept along the bottoms of streams that abrasion has had the greatest effect.

Since increased velocity increases the carrying power of water, the texture of the alluvial deposits varies markedly according to the swiftness of the current by which the material is laid down. Accordingly coarse material is much more in evidence along the smaller, swifter headwater streams and near the banks of larger streams than in the broader bottoms along the lower courses, and away from the banks, where the velocity is checked by trees and increased friction resulting from shallower depth. The alluvium of the smaller drainageways of the Appalachian province and the higher portions of the Piedmont frequently

contains large quantities of sand, gravel, and bowlders, whereas that of the broad-bottomed major streams, particularly in regions of lower relief, such as the Atlantic and Gulf Coastal Plains, seldom carries material coarser than medium sand, the greater part, especially of the first bottoms, consisting of silt and clay. The older alluvium of the terraces along many of these large streams, however, even near the coast, carries much gravel, particularly in the substratum. This coarse material was deposited when the streams were flowing at higher levels at a time when the currents were undoubtedly much swifter than under present conditions of streams flowing more nearly at base level.

While there has been considerable assorting of stream-carried material by variations of current and some wearing down of the coarser particles swept along the bottoms of channels, the streams have done much less of this work than have the waters of the ocean, especially with the bulk of transported material, the silts, clays, and fine sands. The gravel and coarser sands are largely left along the upper courses, the fine and medium sands in the natural levees along the banks, while the very fine sand, clay, and silt particles, constituting the bulk of water-borne material, enter the sea to be thoroughly assorted. The coarser particles partly come to rest in the broad alluvial bottoms and partly drop out in shallow water near shore, and the finer ones go farther out into deep water. On reaching the floor of the sea the sand carried along the channel bottoms and the coarser silt particles are subjected to abrasion and assortment by the unceasing agitation of waves and tides, until thrown upon the beaches and carried out of reach of the waters by wind.

In the narrow bottoms the alluvium averages far more variable in texture than in the broad bottoms, for the reason that the narrow strips are more generally developed along smaller streams having a steeper gradient and greater current velocity, and for the additional reason that their smaller area is necessarily affected more completely by the variable material washed down from adjacent slopes and brought in by the smaller tributaries.

Over the bottoms of the smaller streams heavy overflows deposit sand and gravel in those places where the current is suddenly checked by such obstructions as vegetation and hummocks, while finer material is laid down close by from the water thus relieved of its coarser burden. As the flood subsides still finer grains settle out in the lower positions from the slackened currents and clay and silt are deposited from the pools of water left in depressions. Again, the entire flood plain may be inundated by the water of a tributary carrying material from a different source and of entirely different character. Thus the smaller bottoms usually comprise many textural grades and variable material within restricted areas. The deposits are also extremely variable in texture and character from the surface downward.

There has been relatively little opportunity for changes in the first-bottom deposits by weathering on account of the exclusion of air by the presence of an excessive quantity of water and for the reason that fresh deposits are continually being added. On the other hand, a great part of the terrace material is well drained and has stood above overflow long enough to have been materially altered by weathering, erosion, and percolating water. Some of these better-drained portions of the terraces comprise material which closely resembles the still older upland material, the similarity often being closer than that existing between the material of the first bottoms and terraces. This is particularly true in the Coastal Plains regions, where the uplands material as well as that of the terraces is of water-laid origin. Such resemblance is but the natural outcome of identical agencies of weathering and erosion operating toward the same end, frequently upon material originally from about the same source. Close examination, however, usually shows a difference between the character of the material of the terraces and uplands, while a microscopic examination probably would reveal dissimilarity in the mineralogical composition and in the shape of the particles between the materials of the most closely related portions of the terraces and uplands. The terrace material has not been so completely weathered and has not been subjected to such severe processes of mineralogical simplification, such as the wearing down of the mineral aggregates by attrition resulting from the movement of waves and tides, as the Coastal Plain sediments. Practically all the alluvial material of both old and recent deposits probably contains a larger percentage of minerals other than quartz than does Coastal Plain material of similar texture.

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There is generally a much closer resemblance between similar textured materials of the poorer-drained portions of the terraces and first bottoms than exists between the corresponding materials of the well-drained portions.

SOILS.

The principal soils of the River Flood Plains province consist of clays, silt loams, loams, and variable undifferentiated materials classified as Meadow and Swamp. Of the area surveyed the clays occupy 22.5 per cent, the silt loams 24.3 per cent, the loams 8.9 per cent, and Meadow and Swamp 23.4 per cent, while the entire area comprised by soils of a coarser texture than loam is only 12.1 per cent of the total. The areas mapped as Meadow include considerable sandy soil, but dominantly the material is not lighter in texture than loam. In the broader bottoms the fine-textured soils comprise the larger area, the coarse types being relatively more extensive on the terraces and in the narrow bottoms.

The source, color, and age of material constitute the important criteria in the classification of the alluvial soils. The source of the material has a direct bearing upon the inherent characteristics of the soils, while the color is indicative of conditions of considerable import, especially as related to productiveness. The age of the deposits as measured by their position, whether in the overflowed bottoms of recent deposition or on the older terraces standing above overflow, has much to do with the physical features and productiveness of the derivative soils.

It has been found impossible to determine the exact source of all the material, or even the greater part in many cases, because the deposits from varied sources have been so intimately mixed as frequently to lose any individual characteristics the particles from a definite region may have possessed. In the case of those streams which rise and have their courses entirely within areas completely occupied by definite or related soils, as is true, for example, of many of the Coastal Plain streams, the exact source of the material is at once obvious. But with streams traversing regions of unrelated soils and receiving the waters of tributaries flowing from still other soil provinces, as in the case of the Mississippi River as an extreme example, it can be safely assumed only that the greater or at least a large part of the material is derived from that region affording the greater part or a considerable part of the drainage waters.

In the case of many streams embracing several soil regions within their drainage basins the source of a considerable part of the alluvium can be readily fixed by certain unmistakable inherent properties of the material, the identity of which has been preserved with sufficient distinctness to dominate the physical qualities of the deposits even where representing an intimate mixture of a variety of dissimilar materials. This is particularly true of materials washed from red soils and calcareous soils.

The Indian-red material derived from the Upshur soils often dominates the color of the bottom lands, including the Moshannon soils, for considerable distances beyond the limits of the parent soil, even where large quantities of sediments from entirely different sources and of entirely different color have been added. The pinkish-colored sediments carried from the Red Beds region of northwest Texas and Oklahoma have given a decidedly pinkish-red color to the bottom lands of streams rising in this section for hundreds of miles below the boundaries of the Red Beds. Along the Brazos River, for example, rising in this region, the Miller soils, which owe their most striking characteristics to the reddish wash from the Red Beds, extend nearly to the Gulf of Mexico, 300 miles or more below the region affording the characterizing sediments. Material derived from calcareous soils frequently imparts distinctive qualities, especially of texture and of productiveness, to alluvial lands for long distances outside the boundaries of such calcareous soils.

It thus appears that while the source of all the material, or even the greater part, entering into the composition of alluvial soils, can not be precisely determined in all cases, a number of factors serve as safe criteria in fixing the origin of at least a part of the component material, usually the dominant part. In the case of some series established upon the basis of the origin of material rather arbitrary lines of limitation are necessarily drawn. The Genesee soils, for example, which in their typical development are derived altogether or largely from light-colored glacial soils, grade into the Huntington soils, which have a very similar appearance, but which typically consist of sediments

washed from the residual soils of the Appalachian and Limestone Valleys regions. Along streams flowing from the glaciated region and entering the Appalachian and Limestone provinces to the south there is a gradual change from alluvium consisting mainly of glacial material to that consisting principally of residual Appalachian and Limestone material, or from the Genesee soils to the Huntington, so that it becomes necessary to fix boundaries which in some cases are somewhat arbitrary.

Frequently, however, the Genesee can safely be extended down into the Appalachian and Limestone provinces until large streams having their main drainage basins within these provinces enter with a burden of unquestionably residual material. Below such points it is obvious that a considerable part of the alluvium is of residual origin, while above it is equally clear that the content of residual material is negligible or small in amount as compared with glacial sediments.

On the basis of color the alluvial soils are easily separated into distinct series of black, brown, gray, yellow, and red soils. The color of the material points either to some important soil condition, such as drainage, amount of organic matter present, or state of oxidation, or to the source of the material. The black alluvial soils are usually poorly drained and subject to the accumulation of dark-colored organic matter; the brown soils ordinarily have relatively good drainage, at least between periods of overflow, while the gray soils exist generally under intermediate drainage conditions; that is, they are better drained than the black soils and not so well drained as the brown. On the other hand, the red alluvial soils prevailingly represent sediments washed from red uplands, although they occasionally consist of material which has assumed a red color through advanced processes of weathering, especially the oxidation of iron salts.

The first-bottom division of the Flood Plains comprises the youngest soils not only of this but of all the provinces, excepting certain eolian soils which are being contemporaneously formed in other provinces through the action of wind. These first-bottom soils are immature in that they are being added to by each overflow, and for the additional reason that the time between overflows is insufficient for and the conditions unfavorable to the advancement of those processes of weathering which have brought about the different characteristics obtaining in older, better-drained normal soils. Oxidation has been inhibited by poor drainage, the outwashing and downward translocation of the finer particles has been prevented or hindered by the frequent deposition of material over the surface, and a minimum of work has been accomplished by erosional processes, owing to the flat surface and the frequent water-soaked condition of the land.

Mainly glacial material.—In those regions where the alluvium is largely derived from glacial material the alluvial terraces (second bottoms) have not been included in this province. Such terraces as exist along stream courses in the glacial region were formed by rushing glacial waters contemporaneous with the recession of the ice. These terraces are characterized by a predominance of coarse sediments, such as coarse sand and gravel, in many cases with a later superficial deposition of fine material where the waters were less voluminous. These areas have been included in the Glacial Lake and River Terrace province.

The most extensive series of first-bottom alluvium consists of the brownish Genesee soils, which are confined principally to the timbered portion of the glacial till region, occurring mainly in New York, Ohio, Indiana, Michigan, and Wisconsin. The Podunk series comprises the brownish first-bottom soils washed largely from material of the glacial crystalline rocks in New England. The other series of alluvial soils derived from glacial material are mainly local in their distribution.

Mainly loessial material.—The area of the alluvial soils genetically ascribed to loessial material is more extensive than that of any of the other groups of the River Flood Plains province. Under this head have been classed the soils of the Mississippi River bottoms, as well as those of the large and small streams throughout the last loessial region of the North Central States and the strips of loess extending down the Mississippi River.

None of these soils consist wholly of loessial material. Those of the Mississippi bottoms are extremely heterogeneous in origin of the material. They include wash from loessial, glacial, and a variety of residual soils—in brief, from all the soils lying within the influence of the surface run-off of the vast Mississippi drainage basin. Nevertheless, much of the water carried by the

Mississippi comes from loessial regions, and it is therefore safe to assume that a large part of the alluvium has been transported from such areas. A large area of bottom land consisting entirely or almost entirely of wash from loessial soils is developed in the North Central States.

The most extensive series of the province is the Wabash, including soils which typically are mainly or purely of loessial origin. These are largely confined to the North Central States. They are black first-bottom soils of high productivity.

The Sharkey series, represented mainly by the clay type, is the most extensive series of the Mississippi bottoms. The clay content of this series averages high in both soil and subsoil, the sediments representing the finer particles borne in suspension and laid down in comparatively quiet overflow water away from the swifter currents near the channel. The Yazoo soils, on the other hand, consist of the coarser sediments deposited as natural levees in the more rapid currents along and near the banks of streams.

The Sarpy is another extensive first-bottom series belonging to the loessial group. Its most distinctive feature is the light texture of the subsoil material as compared with that of the soil. This feature accounts for the good drainage and consequent high productivity of these soils.

A considerable area of loessial alluvium is occupied by the light-gray Waverly soils, which are rather poorly drained and not so productive as the Sarpy. These occur in flat to slightly depressed situations in the first bottoms where the material is intermittently wet and dry between overflows.

Terrace soils have a moderate development in the loessial group, the brown, productive Lintonia being the most extensive. The Olivier and Iberia are important along the lower Mississippi bottoms. These are somewhat related in their physical features to the soils of the Coastal Prairie division of the Coastal Plains. The type locality is between the Coastal Prairie region and the first bottoms of the Mississippi, and it is possible that these represent an order of soils intermediate between these divisions.

Mainly Coastal Plain material.—Of the group comprising soils derived entirely or largely from Coastal Plain material the Ocklocknee and Bibb are the most extensive of the first-bottom series. The former series includes the brownish and the latter the grayish soils. There are a number of other first-bottom series of more local distribution. The Trinity is probably the most important of these. It includes extensive strips of highly productive alluvium along streams traversing and issuing from the prairie regions of Houston soils in Alabama, Mississippi, and Texas.

The terraces include extensive areas of Cahaba, Kalmia, and Myatt soils, especially in Mississippi, Alabama, and Georgia. The Cahaba series includes the best drained soils of the terraces, the Myatt the poorest drained, and the Kalmia those of intermediate drainage.

Some areas of these, as well as some of the first-bottom series, include varying amounts of material derived from Piedmont and Appalachian soils. The Cahaba particularly carries large quantities of Piedmont and Appalachian material, and also some limestone material, in such developments as that along the Alabama River near the Piedmont border.

Mainly Piedmont material.—The first bottoms of the Piedmont are largely occupied by the Congaree soils. The reddish material comprising the typical Congaree alluvium dominates the color and probably constitutes the greater part of the material of the first bottoms along a number of streams across the Coastal Plain from the Piedmont boundary to the tidal marshes fringing the Atlantic Ocean. Of course, within the Coastal Plain a part of the alluvium along the streams rising in the Piedmont is derived from Coastal Plain soils, but so much more of the dominant Piedmont clay material than of the dominant sandy Coastal Plains deposits is carried in suspension that it is likely the former usually prevails, especially in those bottoms which show a reddish color.

Terrace soils are decidedly inextensive within the heart of the Piedmont Plateau, but two series, the Wickham and Altavista, consisting wholly or largely of Piedmont material, have a moderate development within the lower border zone and just outside the province, in the upper portion of the Coastal Plain. The Wickham is most extensive along the streams north of the Roanoke River.

Mainly Appalachian material.—Of the first-bottom soils derived principally from Appalachian material the Toxaway and Moshannon are the most important. The former are brownish soils derived from the residual soils of crystalline rocks belonging to the Appalachian Mountains or the eastern division of the Appalachian system, while the latter are Indian-red soils washed

from the Upshur soils of the red sandstone and shale regions of the Appalachian system, chiefly the Allegheny Plateau and the mountains of the Great Appalachian Valley.

The Tyler series comprises the gray, poorly drained terrace soils consisting largely of Appalachian material, while the Holston includes the corresponding brownish, well-drained types.

Mainly Appalachian and Limestone material.—An important group consists of soils made up of wash from Appalachian and limestone soils. The most extensive series of these are the Huntington and Holly. These are first-bottom soils, the former representing the better drained, brownish types, and the latter those of grayish color and poor drainage.

Several important terrace series belong to this group. Large areas have been mapped of both the Elk and Cumberland series. The Elk series comprises brown terrace soils with yellow or yellowish-brown subsoils, while the Cumberland includes brown terrace soils with reddish-brown subsoils. The gray Robertsville soils represent the poorly drained terrace series of this group.

Mainly Appalachian, Limestone, and Piedmont material.—Only one series has been recognized as being composed of material washed from the Appalachian, Limestone, and Piedmont provinces. This is the Birdsboro, of Pennsylvania, a terrace soil, mapped along streams heading in the Limestone and Appalachian regions and flowing through the Piedmont.

Mainly Glacial and Appalachian material.—The Wheeling series includes a large total area of terrace soils consisting of wash from the Glacial and Appalachian province. These frequently have a substratum of glacial gravel. They are well-drained, productive soils.

Mainly residual prairie material.—West of the Mississippi River a great many streams are bordered with first and second bottom soils consisting largely of wash from the residual soils of the prairie regions. The Miller is an extensive first-bottom series developed along streams rising in the Red Beds region. These soils are of pinkish-red color and are extremely productive. The Osage occurs in considerable areas in the first bottoms of streams receiving drainage from the residual prairie sandstone and shale soils. The Auglaize includes black first-bottom types derived from residual prairie limestone material.

Large areas of alluvial lands are comprised in the stream bottoms and terraces of west and southwest Texas, where the material consists of wash from residual prairie soils of the semiarid regions. The Rio Grande and Laredo series are representative alluvial soils derived from soils of the semiarid residual prairies.

Miscellaneous materials.—Under the head of "Miscellaneous materials" there have been mapped extensive total areas of Meadow and Swamp.

Meadow consists of undifferentiated first-bottom materials extremely variable in origin, sediments from nearly all the important series entering into this classification as locally mapped. Frequently the material is derived from drainage basins of uniform soil, but everywhere the typical areas of Meadow are of varied texture, both in the surface of restricted areas and throughout the vertical section.

The alluvium classed as Swamp is generally confined to wider bottoms than those occupied by Meadow, where overflows are deeper and of longer duration. The Swamp lands are so poorly drained that extensive engineering operations would be necessary to effect their reclamation, whereas with Meadow individual farmers can handle the work necessary for the reclamation of a large part of the area occupied.

Muck, Riverwash, Marsh, and Overwash are the other classifications recognized under the Miscellaneous Material group. These have not been mapped in extensive areas. Their characteristics are brought out in subsequent type descriptions.

CLIMATE.

Inasmuch as the soils of the River Flood Plains province are developed over a very large area, it is evident that the climatic variation is wide, ranging from the subtropical conditions of southern Texas and Florida to the long winters in the latitude of the Canadian border, and from semiaridity in the vicinity of the one hundredth meridian to humidity along the Atlantic shores. These variations naturally effect a wide range in the crop adaptations of the soils and in the character of agriculture from north to south and from west to east. In Florida and the south Gulf region of Texas the alluvial soils, where properly

drained, can be successfully used for the out-of-doors production of winter vegetables and citrus fruits, whereas in the northern portions of North Dakota, Minnesota, Wisconsin, and New England the summers are so short that only the very earliest varieties of corn reach maturity in favorable localities, and this corn is generally too soft for the best milling purposes, while the winters are too severe for best results with winter wheat.

Along the western border of the region, near the one hundredth meridian, the rainfall is so scant that crops are generally not sure except under irrigation. Dry-farming methods are practiced here to a considerable extent, summer fallowing being practiced one year to conserve moisture for the next year's crop. The greater part of the alluvial soils, however, are subject to frequent overflow and to abnormal wet conditions between periods of overflow, necessitating greater effort to rid the land of excess moisture rather than to provide sufficient moisture.

Locally narrow bottoms and terraces inclosed by high bluffs are not suited to fruit, owing to inclemency of the climate, particularly poor air drainage or the tendency of heavy, cool air to settle in such situations. For the same reason early vegetables can not be grown successfully in the deep, narrow valleys, even where the soil is properly drained.

AGRICULTURAL VALUE OF ALLUVIAL SOILS.

The soils of the River Flood Plains province comprise a vast area of extremely fertile land. Consisting of sediments washed from a great many sources, including cultivated and timbered lands intimately mixed among themselves and with varied organic matter and deposited in positions where leaching and weathering have not had opportunity to alter its condition to any considerable degree, a very large part of the overflowed alluvium represents the most fertile lands known. The soils possess great potentialities and only require drainage and protection from overflow to become producers of a variety of crops. Already a large acreage has been brought under profitable cultivation, and it is likely that the cultivated area will continue to be enlarged steadily until the whole is utilized.

A total of 17,794,171 acres have been surveyed in this province on the detail scale of 1 inch to the mile and 4,451,968 acres on the reconnoissance scale of 1 inch to 4 to 6 miles, with an overlap of 572,480 acres, leaving a net amount of 21,673,659 acres actually covered. Of this amount 16,212,420 acres have been classified by series, 14,987,396 acres of which have been classified into types. There are 5,461,239 acres of miscellaneous material either nonagricultural or requiring extensive reclamation to prepare them for agricultural use.

DESCRIPTION OF THE SOIL SERIES.

Abernathy series.—The surface soils of the Abernathy series are red, while the subsoils are mottled reddish, brown, and gray or grayish. The soils are developed in the first bottoms of streams, where they are subject to overflow and poor drainage. They are derived principally from Decatur material. When properly drained they are well suited to corn, oats, grass, and cotton.

Area and distribution of the soils of the Abernathy series.

Soil name.	State or area.[1]	Acres.
Abernathy silt loam	Alabama 10	832
silty clay loam	Alabama 26	10,816
Total		11,648

[1] For key to numbers in this column see p. 733.

Altamaha series.—The soils are prevailingly of dark-drab to dark bluish color and heavy texture, and the subsoils are slate-blue to bluish-drab or bluish-gray in color, often with reddish-yellow and yellowish mottlings, and of silty clay texture and plastic structure. Lime concretions are occasionally encountered in the lower subsoil. Cultivation is difficult on account of the intractable structure of the soils when dry and their sticky character when wet. In origin these soils are closely associated with the Georgetown series, probably having been

deposited by the rivers under estuarine conditions. They are subject to tidal overflow with fresh to brackish river water where not protected by dikes. The most characteristic feature of the series is the bluish color of the material.

Area and distribution of the soils of the Altamaha series.

Soil name.	State or area.[1]	Acres.
Altamaha clay loam	Georgia 10	640
clay	do	384
Total		1,024

[1] For key to number in this column see p. 733.

Altavista series.—The surface soils are gray; the subsoils are yellow or mottled yellow and gray, or yellow, gray, and red. The series is developed as well-defined to rather indistinct terraces along streams, and lie above normal overflow. The soils are encountered in the Piedmont region and in the near-by Coastal Plain along streams issuing from the Piedmont. Typically the material is alluvial in origin, but in places near foot slopes some colluvial material has modified the alluvial deposits. In places also the subsoil appears to be at least partly residual in origin. The flatter areas need surface drainage. Tobacco, corn, wheat, oats, and grass do well.

Area and distribution of the soils of the Altavista series.

Soil name.	State or area.[1]	Acres.
Altavista sandy loam	Virginia 4	1,088
fine sandy loam	North Carolina 15	3,968
loam	North Carolina 23	6,080
silt loam	North Carolina 11, 23	2,624
Total		13,760

[1] For key to numbers in this column see p. 733.

Amite series.—The Amite series is marked by the brown to chocolate-brown or reddish-brown color of the soils, and by the reddish-brown to red color of the subsoils. There is frequently a substratum of water-rounded gravel at a considerable depth below the surface. The soils occur on stream terraces above normal overflow. The material is of alluvial origin, having been derived principally from the silty soils of Louisiana and Mississippi near the Mississippi River. The soils are well suited to the general farm crops of the region, the sandy members being particularly adapted to strawberries and a variety of vegetables.

Area and distribution of the soils of the Amite series.

Soil name.	State or area.[1]	Acres.
Amite sandy loam	Louisiana 13	7,232
loam	do	16,320
Total		23,552

[1] For key to number in this column see p. 733.

Aroostook series.—The soils are dark-brown and are generally quite mellow in structure. They are alluvial, being derived mainly from glacial till of limestone origin. They occur in the first bottoms and occasionally upon indistinctly developed second terraces. Spring overflows are common, but little trouble is had from this source during the growing season. The soils are very productive, making heavy yields of Irish potatoes of excellent quality, grass, and grain.

Area and distribution of the soils of the Aroostook series.

Soil name.	State or area.[1]	Acres.
Aroostook sandy loam	Maine 1	960
loam	do	64
silt loam	do	2,432
Total		3,456

[1] For key to number in this column see p. 733.

Auglaize series.—Both the soils and subsoils of the Auglaize series are black. The surface portion is usually of friable structure. These soils are of alluvial origin and are subject to stream overflow. The material is derived from the black residual limestone soils of the Ozark region.

Area and distribution of the soil of the Auglaize series.

Soil name.	State or area.[1]	Acres.
Auglaize silt loam	Missouri 11	2,816

[1] For key to number in this column see p. 733.

Austin series.—The soils are grayish to light brown. The subsoils are grayish and of calcareous nature. These soils occupy level stream terraces standing above overflow. The material is of alluvial origin, having been derived from the residual prairie soils of south-central Texas. They are well suited to cotton, corn, fruit, sorghum, and a number of vegetables, especially under irrigation. Alfalfa has been successfully grown.

Area and distribution of the soil of the Austin series.

Soil name.	State or area.[1]	Acres.
Austin fine sandy loam	Texas 25, 33	32,576

[1] For key to numbers in this column see p. 733.

Barbour series.—The soils of the Barbour series are reddish-brown or brownish-red to Indian-red in color, with Indian-red subsoils. The topography is level to somewhat undulating, the soil being developed in first bottoms in glacial regions. The material is derived from the wash from red till upland soils, such as the Lackawanna series. Where stone or gravel is present it will generally be found to consist principally of red shale and sandstone from the Catskill or Medina formations. The soils are subject to overflow and usually have naturally poor surface drainage. There is some range in elevation above the streams, and where the tendency to overflow is least, and where, as sometimes occurs, stratified gravel underlies the soils at about 3 feet and assists the downward movement of water, the series is valuable for general farm and truck crops.

Area and distribution of the soils of the Barbour series.

Soil name.	State or area.[1]	Acres.
Barbour gravelly loam	Pennsylvania 4	3,648
silt loam	do	4,416
undifferentiated	Pennsylvania 13	10,368
Total		18,432

[1] For key to numbers in this column see p. 733.

Bastrop series.—The soils are brown, with reddish-brown to red subsoils. The series represents old alluvial material brought down by streams from the Permian Red Beds and deposited as terraces now almost entirely above overflow. The soils constitute excellent farming lands.

Area and distribution of the soils of the Bastrop series.

Soil name.	State or area.[1]	Acres.
Bastrop sandy loam	Texas 3	7,680
fine sandy loam	Texas 2, 3, 33	61,440
silt loam	Texas 3	6,080
clay	do	12,352
Total		87,552

[1] For key to numbers in this column see p. 733.

Bibb series.—The Bibb series is marked by light-colored to white, compact surface soils and by compact, plastic, and white or mottled white and yellowish subsoils. These soils are developed in the first bottoms of streams and are subject to overflow and to intermittent wet and dry stages. The material is derived principally from the Coastal Plain soils. Under present drainage conditions the yields are low. With the establishment of good drainage by ditching, corn, oats, and forage do well and cotton moderately well. In their present condition the Bibb soils are best suited to grass and pasturage.

Area and distribution of the soils of the Bibb series.

Soil name.	State or area.[1]	Acres.
Bibb sandy loam	Alabama 8, 32	4,352
fine sandy loam	Alabama 37; Mississippi 9, 14.	26,752
loam	Alabama 22; Mississippi 15	50,304
silt loam	Alabama 3, 37; Mississippi 5, 9, 10.	35,264
clay	Mississippi 15	7,360
Total		124,032

[1] For key to numbers in this column see p. 733.

Birdsboro series.—The soils are yellowish brown to brown, and the subsoils yellow to yellowish brown. Occasionally water-rounded stones and gravel are scattered over the surface and mixed with the soil. The soils consist of alluvial or water-worked material, a great part of which is derived from Appalachian limestone and Piedmont material. They have been mapped only in the Piedmont of Pennsylvania. This is essentially a river-terrace series. The topography is nearly flat to gently rolling, and the drainage is good. The soils are fairly well suited to the general farm crops.

Area and distribution of the soil of the Birdsboro series.

Soil name.	State or area.[1]	Acres.
Birdsboro silt loam	Pennsylvania 3	3,840

[1] For key to number in this column see p. 733.

Biscoe series.—The soils of the Biscoe series are chocolate brown, with yellow subsoils whose lower portions are sometimes mottled with gray. The surface is gently rolling, and the drainage is fairly well established. These soils represent old stream alluvium, no longer subject to overflow. The material is derived largely from the silty soils occurring in the prairie regions of Arkansas and Louisiana. The principal timber growth consists of several varieties of oak. A large part of the series is under cultivation, chiefly to cotton, which gives good results. Corn, forage crops, and lespedeza are grown with fair success. Alfalfa could be profitably grown.

Area and distribution of the soil of the Biscoe series.

Soil name.	State or area.[1]	Acres.
Biscoe silt loam	Arkansas 4	12,992

[1] For key to number in this column see p. 733.

Blanco series.—The Blanco series has gray to light-brown soils and brownish subsoils, which in the lower portions change into plastic, heavy material of a decidedly brown color. The soil and subsoil are calcareous. These soils occupy stream terraces standing mainly above overflow. The material is of alluvial origin, having been derived chiefly from residual prairie soils of southern central Texas. The soils are well adapted to the general farm crops of the region, particularly to cotton, corn. Irish potatoes, sweet potatoes, and alfalfa. Better yields are secured with irrigation.

Area and distribution of the soils of the Blanco series.

Soil name.	State or area.[1]	Acres.
Blanco loam	Texas 26	5,376
undifferentiated	Texas 28	96,448
Total		101,824

[1] For key to number in this column see p. 733.

Buckner series.—The color of the surface soils is dark brown to nearly black. The subsoils are lighter in color and frequently lighter in texture than the surface soils. The series is developed as terraces or flat-topped ridges, holding essentially the position of a terrace or second bottom in the alluvial bottoms of the Mississippi River and such tributaries as the Missouri. The material is alluvial in origin. Where protected from overflow by its higher position good crops of cotton, corn, grass, forage, and grain are secured.

Area and distribution of the soil of the Buckner series.

Soil name.	State or area.[1]	Acres.
Buckner loam	Missouri 10	320

[1] For key to number in this column see p. 733.

Buxin series.—The soils of the Buxin series are reddish, with subsoils of mottled rusty-brown, bluish-drab, and yellowish color and plastic structure. The surface soil consists of Miller material and the subsoil of Sharkey material. The series simply represents a deposition of the Miller over Sharkey. It occupies the flood plains of the Mississippi River. The soils are extremely fertile, and with protection from overflow and drainage produce excellent yields of sugar cane, rice, corn. grass, and forage. Cotton would do well provided the ravages of the boll weevil could be checked.

Area and distribution of the soil of the Buxin series.

Soil name.	State or area.[1]	Acres.
Buxin silt loam	Louisiana 4	2,560

[1] For key to number in this column see p. 733.

Cahaba series.—The surface soils are brown to reddish brown and the subsoils are yellowish red to reddish brown. The series occupies old stream terraces, lying largely above overflow, and represents the best drained lands of such terraces. They are most extensively and typically developed in the Gulf Coastal Plain of Alabama and Mississippi. The component material consists of wash from Coastal Plain soils, with more or less mixture along the larger streams issuing from the Appalachian Mountains and Piedmont Plateau of material derived from the soils of those regions. These soils are admirably suited to the production of cotton, corn, oats, and forage crops. Some of the heavier, better drained areas could be successfully used for alfalfa.

Area and distribution of the soils of the Cahaba series.

Soil name.	State or area.[1]	Acres.
Cahaba sand	Alabama 32; Mississippi 5, 10	17,792
loamy sand	Mississippi 5, 20	18,240
fine sand	Alabama 2, 18; Mississippi 3, 5, 14	6,912
sandy loam	Alabama 8, 18, 31, 32, 37; Mississippi 5	32,960
fine sandy loam	Alabama 1, 2, 3, 12, 14, 17, 34, 37; Mississippi 3, 5, 9, 10, 12, 14, 20; South Carolina 8.	314,688
loam	Alabama 2, 14, 17, 37; Mississippi 12	70,976
silt loam	Alabama 1, 3, 14, 37; Mississippi 5, 9, 10, 12	94,656
clay	Alabama 13, 18, 30; Georgia 8; Mississippi 10, 14, 20; North Carolina 7.	109,056
Total		665,280

[1] For key to numbers in this column see p. 733.

Calhoun series.—The soils of the Calhoun series are of gray color and heavy texture. The heavy clay subsoils are of gray or drab color and tenacious, waxy structure. Iron concretions are common and in places there is a substratum of sandy material. These soils occupy poorly drained, flat stream terraces, on which water stands for long periods after rains. They are not subject to overflow. The material is of alluvial origin, derived principally from the silty soils of the prairie regions of Arkansas and Louisiana. With proper drainage, the soils are well suited to cotton.

Area and distribution of the soil of the Calhoun series.

Soil name.	State or area.[1]	Acres.
Calhoun clay	Arkansas 4	12,672

[1] For key to number in this column see p. 733.

Cameron series.—The Cameron series includes soils of dark-brown to black color and tenacious character, and highly calcareous subsoils, which are lighter in color than the surface soils. Lime concretions are of frequent occurrence in the deeper subsoil. The series occupies broad, shallow basins, occurring typically between abandoned river channels, and in general is poorly drained. The lower portions of the basins receive the drainage water from surrounding soils and remain in a flooded condition during the greater part of the year. Alkali is frequently present in the lower depressions, but when the soil is well drained the alkali salts do not injure crops. The material of this series is of alluvial origin, deposited chiefly by overflow waters of the Rio Grande. Both the soil and subsoil are calcareous. The better drained areas along the upper slopes of the basins support a heavy growth of mesquite, cactus, and other native vegetation. The growth becomes lighter toward the depressions, the lowest portions of which support only a growth of coarse marsh grasses. Good crops of corn, sugar cane, cotton, and a number of vegetables are successfully grown on the better drained areas.

Area and distribution of the soil of the Cameron series.

Soil name.	State or area.[1]	Acres.
Cameron clay	Texas 5, 27, 28	152,064

[1] For key to numbers in this column see p. 733.

Catalpa series.—The Catalpa soils are light gray to grayish brown, with mottled gray and brown to black, silty clay subsoils, consisting chiefly of Trinity material. They are developed in the first bottoms of streams flowing through and issuing from the Houston soils. The series is characteristically developed along the outer edge of the bottoms, where the soils usually lie a little higher than the Trinity clay and have better drainage. The grayish color and highly calcareous nature of the surface soil is due to comparatively fresh deposition of material washed from near-by exposures of the Houston chalk, or "rotten limestone," of the prairie belt. The subsoil material generally consists of the wash from the Houston clay. The soils are usually lacking in organic matter, but are very productive, being especially adapted to cotton, corn, Bermuda and Johnson grass, oats, sorghum, and sugar cane. Alfalfa would do well where good drainage is secured.

Area and distribution of the soils of the Catalpa series.

Soil name.	State or area.[1]	Acres.
Catalpa silt loam	Mississippi 15	5,056
silty clay loam	Mississippi 10	3,968
Total		9,024

[1] For key to numbers in this column see p. 733.

Chariton series.—The Chariton soils are dark in color, ranging from dark gray to black. They belong to the Terrace group of soils in the River Flood Plains province. The type locality is Macon County, Mo., where the soils occur on terraces adjoining the bottom lands of Chariton River and its tributaries. The material is an ancient flood-plain deposit of the Chariton River and its tributaries which carry and deposit material derived almost exclusively from the Kansan till and the silty clay layer that overlies it in the Middle Western States. There are usually three layers of material in the 3-foot soil and subsoil section. The upper layer is light, the lower intermediate, and the middle layer, which usually extends from about 16 to 24 inches in depth, heavy.

Area and distribution of the soil of the Chariton series.

Soil name.	State or area.[1]	Acres.
Chariton silt loam	Missouri 12	15,936

[1] For key to number in this column see p. 733

Chastain series.—This series includes grayish to dark-gray surface soils and gray to mottled gray and yellow subsoils. There is usually a substratum of mottled red and gray, impervious, plastic clay which hinders drainage. These soils occupy first bottoms of streams in the southern Coastal Plain region. The material consists of sediments derived from Coastal Plain soils. Owing to the poor drainage and the predominant sandy character of these soils, they are considered poor agriculturally and have not been utilized to any considerable extent.

Area and distribution of the soils of the Chastain series.

Soil name.	State or area.[1]	Acres.
Chastain fine sand	Alabama 2	4,672
fine sandy loam	Georgia 11, 16	28,928
Total		33,600

[1] For key to numbers in this column see p. 733.

Collins series.—The soils of the Collins series are brown and silty, with gray subsoils. The series is developed in the first bottoms of streams, where it is subject to overflow and not thoroughly drained. The material is of alluvial origin, having been derived from the loessial soils of Arkansas and Louisiana. The principal crops are cotton, corn, and Irish potatoes, all of which do well.

Area and distribution of the soil of the Collins series.

Soil name.	State or area.[1]	Acres.
Collins silt loam	Arkansas 4	8,576

[1] For key to number in this column see p. 733.

Congaree series.—The soils and subsoils of the Congaree series are brown to reddish-brown, there being comparatively little change in texture, structure, and color from the surface downward. Occasionally grayish and yellowish mottling is encountered in the subsoil of the poorly drained area. These soils are developed in the overflowed first bottoms of the streams of the Piedmont region and in similar positions in the Coastal Plain along streams issuing from the Piedmont. The material is derived from the soils of the Piedmont region, with some mixture of Appalachian material, and in the Coastal Plain a slight mingling of Coastal Plain material. The soils are very productive, but are usually poorly drained and crops are sometimes damaged by overflows. Extensive areas are under cultivation to cotton, corn, cane, oats, and forage crops.

Area and distribution of the soils of the Congaree series.

Soil name.	State or area.[1]	Acres.
Congaree fine sand	North Carolina 23	2,112
sandy loam	Alabama 7	43,648
fine sandy loam	Alabama 33; Georgia 13; North Carolina 10, 17; South Carolina 13; Virginia 4.	51,072
loam	Alabama 7, 33; Mississippi 16; North Carolina 5, 23; South Carolina 16; Virginia 5.	155,520
silt loam	Alabama 8; Georgia 5; North Carolina 11; South Carolina 9	19,072
silty clay loam	North Carolina 3	7,360
clay	Mississippi 11; North Carolina 7, 22; South Carolina 10, 14	52,832
Total		331,616

[1] For key to numbers in this column see p. 733.

Cumberland series.—The surface soils are brown to yellowish brown in color, while the subsoils are yellow to reddish yellow. The series comprises high-terrace soils in the limestone region of the South. Many of the larger streams traversing the limestone region formerly flowed at considerably higher levels, and this resulted in the formation of more or less distinct terraces. Upon these terraces was deposited a stratum of sedimentary material. Typically the material consists of alluvium derived largely from limestone soils. In places the subsoil is residual from limestone.

Area and distribution of the soils of the Cumberland series.

Soil name.	State or area.[1]	Acres.
Cumberland sandy loam	Kentucky 3	896
fine sandy loam	Alabama 35; Kentucky 3	5,696
loam	Kentucky 2; Tennessee 2, 4, 5; Virginia 9	61,184
gravelly loam	Alabama 26; Virginia 9	4,800
silt loam	Missouri 11; Tennessee 12	7,872
clay loam	Virginia 9	192
Total		80,640

[1] For key to numbers in this column see p. 733.

Dunning series.—This series includes dark-gray to black soils of high organic-matter content. The subsoils are mottled yellow, drab, and bluish. These soils are developed in the first bottoms of streams and are subject to overflow. They are of alluvial origin, consisting principally of material washed from limestone, sandstone, and shale soils. They are associated with the Huntington soils in regional occurrence and origin of material, differing chiefly in color and organic-matter content. When properly drained, corn and grass do particularly well.

Area and distribution of the soils of the Dunning series.

Soil name.	State or area.[1]	Acres.
Dunning sand	Wisconsin 7	5,952
clay loam	Pennsylvania 2	768
clay	Missouri 8	384
Total		7,104

[1] For key to number in this column see p. 733.

Elk series.—The Elk series includes light-brown to brown soils and pale-yellow to yellow subsoils. It is developed on second terraces lying largely above overflow. The material is entirely alluvial, and is derived from the soils of limestone, sandstone, and shale formations. These soils contain a larger amount of limestone material than do the Holston soils. Gravelly material is frequently encountered in the substratum. In places the surface is so flat that water stands after wet seasons. With good drainage and careful management the soils are adapted to corn, wheat, oats, grass, and forage crops. They are generally more productive than the corresponding members of the Holston series.

Area and distribution of the soils of the Elk series.

Soil name.	State or area.[1]	Acres.
Elk fine sandy loam	Alabama 28	3,008
loam	Alabama 26; Tennessee 1	22,016
silt loam	Kentucky 4; Missouri 4, 8; Pennsylvania 18; West Virginia 1, 5.	41,088
clay	Alabama 19	6,080
Total		72,192

[1] For key to numbers in this column see p. 733.

Franklin series.—The soils are brown, with light-brown subsoils. They occupy first bottoms of streams, but are seldom overflowed, lying a little above the frequently overflowed bottoms. The material is of alluvial origin, derived largely from the Lamar soils. The series is not considered productive, although it is utilized in part for the production of cotton.

Area and distribution of the soil of the Franklin series.

Soil name.	State or area.[1]	Acres.
Franklin loam	Texas 7	1,280

[1] For key to number in this column see p. 733.

Frio series.—The Frio series consists of dark-colored soils which have been brought down from the Edwards Plateau and deposited as terraces along the larger streams. Along the immediate banks narrow lower strips are sometimes found which are still being added to by each successive overflow, but the proportion of recent alluvium is small. In formation and position the series resembles the Blanco and Laredo series, but differs from them in having less lime, a higher percentage of organic matter, and a darker color. The types have a level topography, are fairly well drained, and are excellent agricultural soils.

Area and distribution of the soils of the Frio series.

Soil name.	State or area.[1]	Acres.
Frio fine sandy loam	Texas 28	165,888
loam	do	73,728
silty clay loam	do	184.320
clay	do	37,952
Total		461,888

[1] For key to number in this column see p. 733.

Genesee series.—The Genesee series consists of dark-brown to grayish-brown alluvial sediments deposited along the major streams and their tributaries throughout the northeastern glaciated region, particularly where the Dunkirk, Volusia, Miami, and Ontario series constitute the principal upland soils. The soils of this series also occur for a short distance south of the glaciated area, where main streams have their headwaters in areas covered by these soil series. The sandy members of the series are prevailingly light brown to gray and the loam and silt loam members darker brown. The soils of this series are subject either to annual or frequent overflow. Where they can be protected from destructive overflow they are recognized as strong soils for grass and pasture, corn, oats, and, in some instances, sugar beets, cabbages, potatoes, and similar crops.

Area and distribution of the soils of the Genesee series.

Soil name.	State or area.[1]	Acres.
Genesee sand	Wisconsin 3	512
fine sand	do	5,504
sandy loam	Pennsylvania 7	4,576
fine sandy loam	New York 2, 6, 10, 11; Wisconsin 8	24,832
very fine sandy loam	Pennsylvania 4	2,944
loam	New Jersey 2; New York 1, 3, 6, 8, 9, 10, 12, 13, 14, 15; Ohio 2; Pennsylvania 7; Wisconsin 1, 8.	128,768
shale loam	New York 6, 13	2,944
silt loam	New York 6, 10, 13; Pennsylvania 4, 7	50,432
silty clay loam	New York 10, 13; Pennsylvania 7	5,504
clay loam	New York 6	960
undifferentiated	Pennsylvania 13, 14, 16	177,152
Total		404,128

[1] For key to numbers in this column see p. 733.

Georgetown series.—The Georgetown soils are of mottled drab and rusty-brown or reddish-brown color and prevailingly silty clay or silty clay loam texture. The subsoils are of mottled drab, reddish-brown, or rusty-brown and

bluish or grayish color, plastic, sticky structure, and prevailingly silty or clay texture. In places the drab predominates in the surface soil in such a way as to give the surface when dry a distinct grayish color, while in other places the brownish color predominates, giving the surface when dry a distinct brownish color. In the lower subsoil, which is always saturated and consequently soft or mushy, bluish or bluish-drab colors are predominant. Mucky material often occurs in the subsoil, in places very near or at the surface. Logs also are frequently encountered in the subsoil and substratum. The soils comprise the lower alluvial lands of streams rising in the Piedmont Plateau. They are subject to daily inundation with fresh to slightly brackish water. Lying between Tidal marsh, which is subject to daily inundation with salt water, and the Congaree soils along the streams above the influence of tidal overflow, these soils occupy a gradational position between the Congaree and Tidal marsh. The material is essentially the same in origin as that of the Congaree, but its color has been changed by poorer drainage conditions. Formerly the soils were diked and used for the production of rice. They produced most of the rice grown in this country prior to the development of the industry in Arkansas, Louisiana, and Texas. Recently rice growing on these soils has declined, the dikes are breaking, and the soils gradually reverting to their former tidal swamp condition. By strengthening the dikes and lowering the level of the water table by pumping and underdrainage, good crops of sweet and Irish potatoes, spinach, cabbage, cauliflower, tomatoes, corn, oats, rye, peas, beans, sugar cane, and the bottom-land varieties of cotton probably could be successfully grown, especially with the addition of lime and acid phosphate.

Area and distribution of the soil of the Georgetown series.

Soil name.	State or area.[1]	Acres.
Georgetown clay	Georgia 3, 10; South Carolina 10	69,952

[1] For key to numbers in this column see p. 733.

Griffin series.—This series includes brownish, compact soils and dark-brown, stiff, waxy subsoils. In some places the subsoils show mottling. There is a substratum of gravel, which improves the drainage. The soils occur in the first bottoms of streams where they are subject to overflow. They consist of alluvial material washed principally from glaciated soils. Heavy yields of corn and wheat are secured.

Area and distribution of the soil of the Griffin series.

Soil name.	State or area.[1]	Acres.
Griffin clay	Indiana 8	1,600

[1] For key to number in this column see p. 733.

Hamlin series.—The soils of the Hamlin series are brown to reddish brown and overlie Indian-red or sometimes slightly mottled subsoils. They are usually thin and often underlain at less than 3 feet by the red Medina sandstone, which gives the subsoil its characteristic color. Fragments of the sandstone are frequently scattered throughout the soil material and are seen at the surface. The soils occupy first-bottom positions along small streams, generally having their source in and flowing through areas of the Lockport soils, which are derived partially from the Medina sandstone. The soil material has been deposited in relatively recent times, since the recession of Glacial Lake Iroquois, part of it being of glacial-lake origin and a part resulting from the breaking up and weathering of the Medina sandstone. The soils are adapted to such general farm crops as can be produced on alluvial soils subject to more or less overflow and where drainage is naturally rather poor. They are best suited to pasture.

Area and distribution of the soil of the Hamlin series.

Soil name.	State or area.[1]	Acres.
Hamlin silt loam	New York 10	6,144

[1] For key to number in this column see p. 733.

Holly series.—The Holly series is characterized by the gray color of the surface soils and the mottled gray and yellow or brown color of the subsoil. These soils are developed in the first bottoms and are subject to frequent overflow. The drainage is poor, and in their present condition they are best suited to grasses. The component material is wholly alluvial and is derived from the soils of the sandstone and shale formations of the Appalachian Mountains and from the limestone soils of the Limestone Valleys and Uplands. Not being so well drained as the Huntington, the Holly soils are less productive.

Area and distribution of the soils of the Holly series.

Soil name.	State or area.[1]	Acres.
Holly fine sandy loam	Alabama 20	1,472
loam	Tennessee 1	5,952
silt loam	Alabama 8, 20, 26, 28; Georgia 18; Kentucky 4; Missouri 4	53,120
clay loam	Kentucky 3	896
Total		61,440

[1] For key to numbers in this column see p. 733.

Holston series.—The Holston series consists of yellowish-brown to brown surface soils and yellow subsoils. It is developed on old alluvial terraces, sometimes standing 200 feet or more above the first bottoms of streams. The soils consist principally of material washed from sandstone and shale soils, and on this account are somewhat less productive than the Elk soils, which they closely resemble but which contain more limestone material. The Holston soils are generally underlain by sandstone or shale, and in places the lower subsoil seems to be partly residual from these rocks. The soils give fair to good yields of corn, wheat, oats, grass, clover, and forage crops.

Area and distribution of the soils of the Holston series.

Soil name.	State or area.[1]	Acres.
Holston gravelly sandy loam	Alabama 6, 15	10,624
fine sandy loam	Alabama 6, 11, 15; West Virginia 2	46,400
loam	Alabama 16; Tennessee 4	7,168
silt loam	Alabama 15; Virginia 9; West Virginia 1, 2, 5, 7	56,128
silty clay loam	West Virginia 2	13,248
undifferentiated	Pennsylvania 13, 15	59,904
Total		193,472

[1] For key to numbers in this column see p. 733.

Huntington series.—The Huntington soils are light brown to brown, and the subsoils yellow to light brown. Frequently there is little change in the color or the character of the material from the surface downward. The soils are developed in the Limestone and Appalachian Mountain regions in the first bottoms of streams, where they are subject to overflow. They consist of material derived from limestone, sandstone, and shale soils. They represent the best drained soils of the first bottoms of the region, and are admirably adapted to corn, oats, grass, forage crops, and, under proper climatic conditions, to cotton.

Area and distribution of the soils of the La Crosse series.

Soil name.	State or area.[1]	Acres.
La Crosse sandy loam	Wisconsin 9	1,856
fine sandy loam	do	3,072
silt loam	do	23,808
silty clay loam	Wisconsin 7	1,472
Total		30,208

[1] For key to numbers in this column see p. 733.

Laredo series.—The Laredo series consists of gray to light-brown, calcareous soils, with gray, calcareous subsoils. The soils occur as terraces along streams in south Texas and also constitute the principal soils of the Rio Grande delta above overflow. They are made up largely of material which has been brought down from the calcareous and more arid parts of Texas. They are seldom or never overflowed and constitute valuable farming lands when irrigated.

Area and distribution of the soils of the Laredo series.

Soil name.	State or area.[1]	Acres.
Laredo silt loam	Texas 5, 16, 27, 28	294,912
silty clay loam	Texas 5, 27	184,320
clay loam	Texas 16	704
clay	Texas 5, 16, 27	93,312
silty clay	Texas 5	448
Total		573,696

[1] For key to numbers in this column see p. 733.

Leaf series.—The soils of this series are of light-gray to gray color. The subsoils characteristically consist of compact gray or mottled gray and yellow silty clay, which grades downward into mottled red and gray or red and yellow, plastic clay, through which moisture and air move slowly. Iron concretions are of common occurrence on the surface. These soils are developed on stream terraces of the Coastal Plain region. Their agricultural value is rather low.

Area and distribution of the soil of the leaf series.

Soil name.	State or area.[1]	Acres.
Leaf fine sandy loam	Mississippi 5	1,472

[1] For key to number in this column see p. 733.

Lintonia series.—The surface soils of the Lintonia series are light brown or yellowish brown and of silty texture. The subsoils are of slightly lighter color and somewhat more compact structure. The series occupies stream terraces and flat alluvial lands along streams, through which the channels are so deeply cut that overflows are of rare occurrence. In places narrow strips of colluvial material occur, usually adjoining terraces or bottom lands. The material is mainly alluvial and is derived from the Memphis, Richland, and Knox soils. Drainage is well established. The soils are admirably suited to the production of grass and forage crops, corn, oats, Irish potatoes, peanuts, cabbage, and a number of vegetables.

Area and distribution of the soils of the Lintonia series.

Soil name.	State or area.[1]	Acres.
Lintonia fine sand	Illinois 3, 7; Missouri 14	4,352
fine sandy loam	Indiana 2, 3; Kentucky 6	28,416
silt loam	Illinois 9; Indiana 8; Kentucky 6; Louisiana 10; Mississippi 1, 6, 13, 19, 21; Missouri 4; Wisconsin 5, 7.	157,236
Total		190,004

[1] For key to numbers in this column see p. 733.

Miller series.—The Miller series includes soils of chocolate-brown to pinkish-red color, with chocolate-red or pinkish-red subsoils. The soil and subsoil are calcareous. Some of the sandier members are grayish brown in the surface portion. The soils of this series are developed in the first overflow bottoms of streams, usually from the Permian Red Bed region. They are typically developed along the Brazos and Red Rivers in Texas and Louisiana. Considerable areas are but rarely overflowed. The soils are well adapted to cotton, corn, alfalfa. forage crops. and oats. Some of the lighter members give good results with fruit and vegetables.

Area and distribution of the soils of the Miller series.

Soil name.	State or area.[1]	Acres.
Miller fine sand	Arkansas 3; Louisiana 3; Texas 23, 24, 31.	66,944
fine sandy loam	Arkansas 3; Louisiana 3, 12, 14; Oklahoma 1; Texas 11, 24, 31.	203,904
very fine sandy loam	Louisiana 4	1,472
loam	Oklahoma 1, 2	37,184
silt loam	Kansas 10; Louisiana 3, 5, 10; Texas 12, 23, 24, 30, 31.	154,816
clay	Arkansas 3; Louisiana 3, 5, 14; Oklahoma 1; Texas 4, 24, 31.	269,504
silty clay	Texas 12	124,480
undifferentiated	Kansas 10	9,216
Total		867,520

[1] For key to numbers in this column see p. 733.

Moshannon series.—The soils of the Moshannon series comprise the reddish-brown to Indian-red first-bottom alluvial lands, the materials of which have been derived principally from the Upshur or Penn soils. Material from other soils, as the Dekalb, is included, but always enough soil from the Upshur or Penn is present to give the series its characteristic color. The soils of this series are a little more productive than those of the Huntington.

Area and distribution of the soils of the Moshannon series.

Soil name.	State or area.[1]	Acres.
Moshannon fine sandy loam	Pennsylvania 5	3,584
loam	Pennsylvania 2, 5	13,504
silt loam	West Viriginia 1, 5, 7, 8	50,304
clay	West Virginia 7	4,608
undifferentiated	Pennsylvania 13, 15	13,248
Total		85,248

[1] For key to numbers in this column see p. 733.

Myatt series.—The Myatt soils are gray to dark gray. The subsoils are of gray to mottled gray and yellow color and impervious character. The soils of this series represent the poorest drained portions of the Coastal Plain stream

terraces. They lie principally above overflow, but are so flat that water stands for long periods after heavy rains. Occurring in close association with the Cahaba and Kalmia soils, they are composed of about the same character of material, differing principally in their poorer drainage. By ditching, the Myatt soils can be brought into profitable utilization for sugar cane, corn, and a number of forage crops. Lespedeza and a number of native grasses thrive on the poorly drained lands. It is probable that moderate to liberal applications of phosphoric acid would be required to induce the proper maturing of crops, particularly of cotton. Liming also would improve the condition of these lands after they have been drained.

Area and distribution of the soils of the Myatt series.

Soil name.	State or area.[1]	Acres.
Myatt sand	Alabama 2, 9	5,184
fine sand	Alabama 2, 5	67,520
sandy loam	Alabama 1; Georgia 17	36,032
fine sandy loam	Alabama 2, 5, 9; Florida 1, 7; Louisiana 12; Mississippi 10, 12, 15.	86,656
silt loam	Mississippi 5, 10	5,888
clay loam	Mississippi 15	4,096
Total		205,376

[1] For key to numbers in this column see p. 733.

Neosho series.—The Neosho series embraces soils of ashy-gray to almost white color and silty texture, and usually white to drab subsoils, which frequently change quickly into a compact, impervious silty clay, sometimes locally styled "hardpan." In some areas the immediate subsoil is a compact, impervious silty clay continuing to a depth of 3 feet or more, while in other places the lower subsoil is a mottled yellow, gray, or white, loose sandy material. In still other places there is a deep substratum of waterworn gravelly material. These soils occur on flat, gently rolling areas adjoining streams, and appear to represent old alluvial material occupying stream terraces standing above overflow. They are typically developed in the central western States, and are derived largely from silty soils. The organic-matter content is prevailingly low, and the soils are much in need of vegetable matter such as can be advantageously supplied by turning under green leguminous crops. Wheat seems to give the best results, but corn and oats do well when the seasons are favorable. Good yields are secured in seasons of normal rainfall. Much lower yields are made in excessively wet or dry years, as such conditions have a marked effect upon these soils.

Area and distribution of the soil of the Neosho series.

Soil name.	State or area.[1]	Acres.
Neosho silt loam	Kansas 1, 4	30,739

[1] For key to numbers in this column see p. 733.

Ocklocknee series.—These soils are dark gray to brownish, with brownish or mottled brownish, yellowish, and gray subsoils. The members of this series represent the darker-colored soils of the first bottoms along the Coastal Plain streams. They are composed principally of wash from the Coastal Plain soils. With proper drainage, oats, forage crops, and corn give excellent yields, particularly on the heavier types. The soils are subject to damage by overflow.

Area and distribution of the soils of the Ocklocknee series.

Soil name.	State or area.[1]	Acres.
Ocklocknee sand	Alabama 27; Mississippi 9	2,496
fine sandy loam	Alabama 3, 8, 17, 27, 32, 37; Mississippi 9, 10, 14, 20.	209,408
loam	Alabama 18, 22, 30, 32, 34; Mississippi 3, 8, 12, 15, 17.	317,248
silt loam	Mississippi 3, 9, 10, 12	39,360
clay loam	Alabama 29; Mississippi 3, 12, 17.	46,656
clay	Alabama 2, 3, 5, 13; Florida 2; Georgia 1; Mississippi 3, 5, 8, 9, 10, 14, 15, 20.	301,184
Total		916,352

[1] For key to numbers in this column see p. 733.

Olivier series.—The soils of this series are of grayish-brown to brown color, mellow structure, and prevailingly silty character. The subsoils are mottled yellowish and drab. Yellow is the most pronounced color, especially in the upper subsoil, but drab, bright yellow, and various shades of brown and yellow are usually discernible through the subsoil material. These soils are derived from old Mississippi alluvium, and are characteristically developed along the outer margin of the bottoms. They lie a little higher than the Iberia series, and have much better drainage. They are no longer subject to overflow, at least in their typical development, occupying low terraces and natural levees. The surface is nearly flat to slightly undulating. Drainage is mainly well established, but some areas need ditching to hasten the removal of surface water. These soils are variously adapted to sugar cane, corn, cowpeas, peanuts. Irish potatoes, sweet potatoes, rice, and a number of vegetables.

Area and distribution of the soils of the Olivier series.

Soil name.	State or area.[1]	Acres.
Olivier very fine sandy loam	Louisiana 10	1,536
silt loam	do	22,656
silty clay loam	do	9,856
Total		34,048

[1] For key to numbers in this column see p. 733.

Ondawa series.—The Ondawa series includes the brown to dark-colored soils of the first bottoms of eastern New York and western New England. These soils are underlain at varying depths, usually 3 feet or less, by beds of gravel. The soil-forming materials are derived from the wash from glaciated crystalline or semicrystalline rocks of the upland regions of the section.

Area and distribution of the soils of the Ondawa series.

Soil name.	State or area.[1]	Acres.
Ondawa fine sand	New York 17	2,176
silt loam	New York 4, 17	34,240
Total		36,416

[1] For key to numbers in this column see p. 733.

Osage series.—The Osage series consists of dark-gray to almost black soils, composed of alluvial wash from the sandstone and shale soils of the prairie regions. When drained and protected from overflow they produce heavy yields of general farm crops.

Area and distribution of the soils of the Osage series.

Soil name.	State or area.[1]	Acres.
Osage very fine sand	Kansas 9	36,544
fine sandy loam	Missouri 5	11,520
very fine sandy loam	Kansas 9	4,096
silt loam	Kansas 9; Missouri 3, 5	120,192
silty clay loam	Kansas 9; Missouri 5	42,816
clay	Missouri 3	23,232
Total		238,400

[1] For key to numbers in this column see p. 733.

Papakating series.—The soils are dark brown to black, with grayish, drab, or mottled yellow and gray subsoils. They occur along streams in the Glacial province, and the sediments are derived from the wash from upland soils of glacial but not of loessial origin. The soils contain, however, no appreciable amount of stratified gravel, either in the subsoils or developed as a substratum. They are subject to overflow and are usually poorly drained. They are darker in color than the soils of the Genesee or Ondawa series, and differ from the latter in the absence of the substratum of gravel. This series is the eastern representative of the Wabash.

Area and distribution of the soils of the Papakating series.

Soil name.	State or area.[1]	Acres.
Papakating fine sand	New York 5	3,904
fine sandy loam	New York 5	2,176
silt loam	New Jersey 2; New York 5	16,448
clay	New York 5	9,984
Total		32,512

[1] For key to numbers in this column see p. 733.

Pledger series.—The Pledger soils are dark gray to black and consist principally of Houston material, and the subsoils, consisting of Miller material, are yellowish red to chocolate red. The series occupies the first bottoms of streams originating in the Red Beds region and flowing through the Houston soils, and is probably not developed to any great extent outside of Texas. These soils are sometimes locally called "wild peach land." The original timber growth consists of ash, oak, and pecan. The soils are very productive when properly drained and give good results with sugar cane, corn, cotton, and Irish potatoes.

Area and distribution of the soil of the Pledger series.

Soil name.	State or area.[1]	Acres.
Pledger silt loam	Texas 4, 12	57,600

[1] For key to number in this column see p. 733.

Podunk series.—The soils of this series are dark brown in color and overlie lighter brown to brownish-gray or yellowish-gray, sometimes slightly mottled subsoils. The deep subsoil may or may not contain material, such as sand and gravel, noticeably coarser than the upper subsoil. The soils occur as rather high first bottoms, but are subject to overflow. The topography is level to gently undulating, and in some places slight ridges have been formed by wind action. The material for the most part consists of recent alluvium deposited along the streams where sediments are washed from upland glacial till soils, influenced chiefly by granite and gneiss, together with schist and other crystalline rocks. Small flakes of mica are frequently present in the soils of this series. A small part of the Podunk soil series was mapped in the Connecticut

Valley as the fine sandy loam member. This lies above any but unusual overflow and should have been classed with the Hartford series of the Glacial Lake and River Terrace province. The soils of the Podunk series are less well drained than the Hartford soils. In general they are of limited agricultural value, owing to their liability to inunduation and poor natural drainage, though in some localities in the Connecticut Valley they are extremely valuable for the production of grass and heavy truck crops.

Area and distribution of the soils of the Podunk series.

Soil name.	State or area.[1]	Acres.
Podunk fine sandy loam	Connecticut 2; New Hampshire 1, 2; New York 4	28,224
silt loam	Connecticut 1; Massachusetts 1; New Hampshire 1	75,812
Total		104,036

[1] For key to numbers in this column see p. 733.

Rio Grande series.—The Rio Grande series includes dark-brown to black soils, with grayish subsoils of lighter texture. Both soil and subsoil are calcareous. On drying the soils bake and crack. The series is of alluvial origin, and represents deposits laid down by the Rio Grande. The surface is comparatively level, but poorly drained depressions and low, narrow ridges frequently occur over the larger areas. The soils are subject to annual overflow. Large areas of the better drained members of the areas are covered by palms, while the lower depressions support a heavy growth of cane and tules and many varieties of marsh grass. Good yields of cotton and corn have been secured from the better drained areas.

Area and distribution of the soil of the Rio Grande series.

Soil name.	State or area.[1]	Acres.
Rio Grande silty clay	Texas 5, 27	34,560

[1] For key to number in this column see p. 733.

Robertsville series.—The Robertsville soils are gray to grayish brown and prevailingly of silty texture. The subsoils typically consist of a gray to white compact layer of silt loam to silty clay loam, overlying a lower subsoil stratum of compact, impervious, plastic clay of a gray to brownish color, with some faint mottling of reddish brown. Black oxide of iron concretions are common throughout the soil section, being most abundant in the lighter colored, poorer drained situations. The flat surface and impervious subsoil cause many areas to be poorly drained. These soils represent old stream alluvium occupying terraces and abandoned stream valleys no longer subject to overflow. The soil includes material washed principally from limestone, sandstone, and shale soils. They are fairly well suited to shallow-rooted crops. Wheat, bluegrass, alsike clover, and white clover do well.

Area and distribution of the soil of the Robertsville series.

Soil name.	State or area.[1]	Acres.
Robertsville silt loam	Missouri 8	32,192

[1] For key to number in this column see p. 733.

St. Catherine series.—The soils and subsoils of the St. Catherine series are yellow. The material represents outwash from the Lafayette and Port Hudson formations underlying loess. The soils occur as narrow fringes along the foot of bluffs. There is usually a slope away from the bluff line to the contiguous alluvial land. Gravel is quite common throughout the soil mass. Very little of the type has been used for agriculture.

Area and distribution of the soil of the St. Catherine series.

Soil name.	State or area.[1]	Acres.
St. Catherine sandy loam	Mississippi 1	1,280

[1] For key to number in this column see p. 733.

Sanders series.—The Sanders soils are dark gray to brownish, with mottled gray, yellow, and brownish subsoils. The soils of this series represent overflowed alluvial first-bottom land along the streams of eastern Texas. The material is derived largely from the timbered soils of the Norfolk, Orangeburg, and Susquehanna series. The series is, when properly drained. well suited to corn, oats, Johnson grass, Bermuda grass, and sugar cane.

Area and distribution of the soils of the Sanders series.

Soil name.	State or area.[1]	Acres.
Sanders loam	Texas 23, 24	17,408
silt loam	Texas 10, 24, 29	15,680
clay loam	Texas 10	1,064
clay	Texas 10, 20, 29	26,304
Total		61,056

[1] For key to numbers in this column see p. 733.

Sarpy series.—The soils of this series range from light gray to nearly black. They differ from the Yazoo and Wabash soils in possessing loose silty or fine sandy subsoils distinctly lighter in texture than their surface soils. This characteristic provides excellent subsurface drainage and allows the soils to be cultivated earlier in the season than the Wabash soils of similar surface texture and position. The soils occur in the bottoms of the Mississippi and Missouri Rivers and their larger tributaries. When leveed or otherwise protected from disastrous surface flooding the soils are very productive, being adapted to the grains, grasses, corn, and alfalfa.

Area and distribution of the soils of the Sarpy series.

Soil name.	State or area.[1]	Acres.
Sarpy sand	Missouri 15	16,384
fine sand	Missouri 10	1,280
very fine sand	Kansas 5; Missouri 16	4,544
fine sandy loam	Missouri 6, 10, 13, 15	36,096
very fine sandy loam	Kansas 5; Missouri 8, 16	17,024
loam	Missouri 1, 15, 16	47,104
silt loam	Missouri 1, 6, 8	17,728
silty clay loam	Kansas 5; Louisiana 4; Missouri 15, 16	66,304
clay loam	Missouri 1, 10; Nebraska 5	19,776
clay	Kansas 5; Louisiana 4; Missouri 8, 15, 16	49,920
silty clay	Missouri 6, 10	5,440
Total		281,600

[1] For key to numbers in this column see p. 733.

Schuylkill series.—This series comprises dark-brown to black soils and light-brown to reddish-brown subsoils. The surface soils contain fine particles of coal derived from the anthracite-coal region. The series is of alluvial origin and most of it is subject to overflow. A great part of the material is derived from the soils occurring in and near the vicinity of the anthracite-coal region of Pennsylvania, and the soils are generally developed only on streams passing through and issuing from this region. They are adapted to the general farm crops of the section and to a number of vegetables.

Area and distribution of the soil of the Schuylkill series.

Soil name.	State or area.[1]	Acres.
Schuykill fine sandy loam	Pennsylvania 3	2,880

[1] For key to number in this column see p. 733.

Sharkey series.—The soils of the Sharkey series are of yellowish-brown to drab color, with mottled rusty-brown, bluish, drab, and yellowish subsoils of plastic structure. In the slight depressions where water stands for a good part of the year organic-matter accumulations impart a nearly black color to the soil. The series contains a high percentage of clay in both soil and subsoil. These soils occur as bottom lands subject to overflow from the Mississippi River. The component material was mainly deposited some distance back from the river by quiet water. On drying the soil cracks readily, forming small aggregates, and this condition gives rise to the local name, "buckshot land." These soils are poorly drained and subject to annual overflow. When diked and ditched heavy yields of corn, sugar cane, and cotton are secured. The ravages of the boll weevil have been severe on cotton. Rice does well.

Area and distribution of the soils of the Sharkey series.

Soil name.	State or area.[1]	Acres.
Sharkey silty clay loam	Mississippi 1; Missouri 15	20,480
clay loam	Mississippi 1	6,848
clay	Louisiana 4, 6, 7, 10, 11, 12, 13; Mississippi 1, 6, 19, 21; Missouri 4, 15; Texas 14, 18, 23.	1,572,436
Total		1,599,764

[1] For key to numbers in this column see p. 733.

Teller series.—The Teller series includes gray soils and yellow to red subsoils. These soils occupy well-drained stream terraces. They are of alluvial origin, derived principally from residual prairie material. The original growth consists chiefly of oak, ash, elm, and cottonwood. Good yields of cotton, corn, potatoes, melons, and other truck crops are secured.

Area and distribution of the soils of the Teller series.

Soil name.	State or area.[1]	Acres.
Teller fine sand	Oklahoma 2	1,344
fine sandy loam	do	11,712
Total		13,056

[1] For key to numbers in this column see p. 733.

Thompson series.—The soils are grayish brown, while the subsoils are dominantly yellow, although they usually show a mottling of gray and shades of brown and yellow. The subsoil of the heavier members is slightly plastic but not too impervious to admit of good underdrainage where drainage outlets, as ditches, are provided. These soils are developed in the first bottoms of streams in the Coastal Plain region, and they are subject to overflow. They are characteristically poorly drained, though not so poorly as the related Bibb soils. The series holds an intermediate position between the first-bottom Bibb and Ocklocknee series, and are similar in color to the Kalmia soils, which represent an intermediate series between the Myatt and Cahaba terrace soils. The component material has been washed largely from the Coastal Plain soils, such as the Norfolk, Ruston, Orangeburg, and Susquehanna. In their natural condition these soils are best suited to pasturage and hay, but with improved drainage they could be profitably used for such crops as corn, cotton, oats, cowpeas, sugar cane, and sorghum.

Area and distribution of the soils of the Thompson series.

Soil name.	State or area.[1]	Acres.
Thompson sand	Mississippi 20	3,328
fine sandy loam	do	32,448
silt loam	do	1,408
Total		37,184

[1] For key to number in this column see p. 733.

Toxaway series.—The Toxaway soils are light brown to dark brown. The subsoils are yellowish brown to dark brown. This series occupies the first bottoms of streams of the southern Appalachian Mountains, and consists of material derived from the soils of this region, principally from granitic, gneissic, and schistose rocks. They are largely subject to overflow. Along the outer margins there is more or less influence from colluvial material from adjoining slopes. The soils are especially adapted to corn, grass, oats, rye, cabbage, pumpkins, cucumbers, potatoes, and other vegetables.

Area and distribution of the soils of the Toxaway series.

Soil name.	State or area.[1]	Acres.
Toxaway fine sandy loam	North Carolina 13, 27; Virginia 9	25,152
loam	North Carolina 13, 27	11,328
Total		36,480

[1] For key to numbers in this column see p. 733.

Travis series.—The Travis series includes soils of gray to grayish-brown color, and red clayey subsoils of high gravel content. The soils occupy stream terraces, which in places have been sufficiently eroded to form a rolling topography. The material is of alluvial origin, having been washed from the soils of the prairie regions of central Texas. Considerable areas are poorly drained. When good drainage is effected, peaches, plums, pears, and a number of vegetables do well. Cotton, corn, oats, and forage crops give moderate yields.

Area and distribution of the soil of the Travis series.

Soil name.	State or area.[1]	Acres.
Travis gravelly loam	Texas 2, 31	25,728

[1] For key to numbers in this column see p. 733.

Trinity series.—The Trinity soils comprise the dark-brown to black first-bottom alluvial lands derived mainly from the soils of the Houston series. The organic matter content is high, and lime is usually present in sufficient quantities to effect fairly good structural conditions. These soils usually occur as flat lands in comparatively shallow stream valleys. Where well drained, heavy yields of corn, cotton, sugar cane, and alfalfa are secured. Alfalfa does well on the heavier members in those situations lying above normal overflow. When wet the soil is extremely sticky, but on drying out usually cracks and breaks down into a desirable tilth if properly handled.

Area and distribution of the soils of the Trinity series.

Soil name.	State or area.[1]	Acres.
Trinity sandy loam	Texas 14	2,688
fine sandy loam	Texas 1	1,600
loam	Texas 14	25,280
clay	Alabama 17,30; Mississippi 3,10,12,14,15; Texas 1,2,3,4,7,8, 9,10,11,12,14,20,24,26,27,28,29,31,33.	1,231,424
undifferentiated	Texas 12	20,736
Total		1,281,728

[1] For key to numbers in this column see p. 733.

Tyler series.—The surface soils of the Tyler series are gray to grayish brown. The subsoils are yellowish to mottled yellow and gray, and of rather compact and slightly plastic structure. The series is developed on second terraces of streams in that part of the Appalachian region where sandstone and shale soils largely predominate over limestone soils. The drainage is not good, and structural conditions are rather poor for yields. The type is best suited to grazing and hay. With the establishment of good drainage conditions, however, fair yields of wheat, corn, oats, and forage crops are secured.

Area and distribution of the soils of the Tyler series.

Soil name.	State or area.[1]	Acres.
Tyler sandy loam	West Virginia 8	448
silt loam	Alabama 26; West Virginia 1,2,4,5,6,7,8	55,808
silty clay loam	West Virginia 7	4,864
Total		61,120

[1] For key to numbers in this column see p. 733.

Uvalde series.—The Uvalde soils are of alluvial origin and occupy broad, level flood-plains immediately south of the Edwards Plateau. They resemble the San Antonio soils, but, having weathered under more arid conditions, are more calcareous and contain less humus. They are therefore of much lighter color and more loose and floury to the feel.

Area and distribution of the soils of the Uvalde series.

Soil name.	State or area.[1]	Acres.
Uvalde silty clay loam	Texas 28	557,568
undifferentiated	do	317,952
Total		875,520

[1] For key to number in this column see p. 733.

Wabash series.—The Wabash series includes soils of dark-brown to black color and high organic-matter content, and slightly lighter drab or gray subsoils. The members of this series are developed typically in the first bottoms of streams of the Central Prairie States, the material being derived principally from the loessial and associated soils of this region. They extend for many miles down the Mississippi River. The Wabash soils are very strong, being admirably adapted to corn and grass.

Area and distribution of the soils of the Wabash series.

Soil name.	State or area.[1]	Acres.
Wabash fine sand	Indiana 1; Oklahoma 1	16,064
sandy loam	Indiana 10; Ohio 7	6,624
fine sandy loam	Indiana 8, 10; Minnesota 1; Nebraska 6; Oklahoma 1	61,760
very fine sandy loam	Louisiana 4; Missouri 13, 16	13,568
loam	Illinois 10; Indiana 3, 5; Michigan 7; Minnesota 4; Missouri 10, 17; North Dakota 2, 8, 9; Ohio 3, 4, 5, 7, 8, 9; Wisconsin 5, 9, 11, 12, 14.	257,840
silt loam	Illinois 2, 3, 5, 6, 8, 9: Indiana 1, 3, 7, 8, 10; Iowa 2, 4; Kansas 2, 7; Kentucky 6; Minnesota 1; Missouri 1, 6, 7, 9, 10, 12, 13, 16, 17, 18, 19; Nebraska 3, 5, 6; Oklahoma 1; Wisconsin 5, 9.	976,476
silty clay loam	Missouri 1	2,752
clay loam	Indiana 3; Iowa 3; Missouri 1; 21; North Dakota 2	41,280
clay	Illinois 2, 4, 7, 9, 10; Kansas 1, 4; Louisiana 6, 7; Mississippi 6; Missouri 1, 4, 6, 8, 10, 12, 13, 14, 16, 17, 18, 19; Nebraska 5; North Dakota 2; Ohio 10; Oklahoma 2.	362,291
silty clay	Kansas 7; Missouri 1, 12; Oklahoma 1	14,976
undifferentiated	North Dakkota 10	163,584
Total		1,917,215

[1] For key to numbers in this column see p. 733.

Wallkill series.—The surface soils of this series range from gray or yellow to dark brown or black in color and in depth from about 4 to 12 inches. The subsoil consists of a mucky and peaty accumulation of organic matter. The series is developed in low, flat areas in the glaciated regions, either at the sites of old glacial lakes or ponds or along some of the more sluggish streams where alluvial sediments have been deposited upon muck and peat. The muck and peat subsoils extend to a depth of 3 feet or more. In many areas the deposition of the alluvial material over the muck is still in progress.

Area and distribution of the soil of the Wallkill series.

Soil name.	State or area.[1]	Acres.
Wallkill silty clay loam	New Jersey 2	704

[1] For key to number in this column see p. 733.

Waverly series.—The surface soils are light gray in color and overlie gray or mottled yellowish and grayish subsoils. This series is typically developed in the poorest drained portions of the first bottoms of streams passing through and issuing from the loessial region of the Central Prairie States. The soils are subject to overflow, but are extensively used for corn and grass, to which they are fairly well adapted.

Area and distribution of the soils of the Waverly series.

Soil name.	State or area.[1]	Acres.
Waverly fine sandy loam	Illinois 1; Indiana 2, 3, 8; Kentucky 6; Mississippi 4; Missouri 2, 21.	20,800
loam	Indiana 8; Tennessee 6, 8	72,768
silt loam	Arkansas 4, 5; Illinois 1, 2, 4, 9; Indiana 1, 2, 3, 7, 9; Kentucky 1; Louisiana 6; Mississippi 4, 6, 13; Missouri 2, 4, 14, 21; Tennessee 8.	572,416
clay loam	Alabama 17; Illinois 7; Indiana 2, 8; Missouri 14	105,280
clay	Arkansas 4; Indiana 2, 8; Kentucky 1, 6; Ohio 10	201,152
Total		972,416

[1] For key to numbers in this column see p. 733.

Wehadkee series.—The Wehadkee soils are of gray color, compact structure, and prevailingly silty texture, the subsoils of mottled grayish and yellowish to white color, compact structure, and prevailingly clay to silty clay texture.

These soils are developed in the first bottoms of streams, where they represent alluvial material derived from Piedmont soils. They are subject to overflow, and hold the same position in the Piedmont region as do the Bibb soils in the Coastal Plains. They are of low agricultural value and are best suited to grasses.

Area and distribution of the soils of the Wehadkee series.

Soil name.	State or area.[1]	Acres.
Wehadkee loam	Alabama 33	704
silt loam	North Carolina 15	18,560
Total		19,264

[1] For key to numbers in this column see p. 733.

Wheeling series.—The Wheeling soils are brown to yellowish brown, and are underlain by gravel, usually within 3 feet of the surface. They occupy the series of gravel terraces along the Ohio and other rivers flowing from ice-covered regions which were formed about the close of the Glacial Epoch. This series includes terrace soils formed by streams issuing from higher areas in which the upland soils are composed of sandstone ground up by glaciers and of shales. The gravel consists largely of sandstone and shale, although granite and other crystalline rocks are also present. The shale is soft, and the material becomes finer with increasing distance from its source. While of but limited extent, the Wheeling soils are important in their relation to the other soils of the region.

Area and distribution of the soils of the Wheeling series.

Soil name.	State or area.[1]	Acres.
Wheeling fine sand	Ohio 6; West Virginia 2, 6, 7	4,800
sandy loam	West Virginia 4, 7, 10	1,920
fine sandy loam	Ohio 6; West Virginia 6, 7	6,912
gravelly loam	Ohio 6; Pennsylvania 9, 10; West Virginia 4, 6, 7, 10	29,830
silt loam	Ohio 6; West Virginia 2, 4, 6, 7	24,000
silty clay loam	West Virginia 2	3,392
undifferentiated	Pennsylvania 13, 14, 15, 16	234,240
Total		305,094

[1] For key to numbers in this column see p. 733.

Wickham series.—The surface soils are reddish or reddish brown, and contain a higher percentage of organic matter than the Norfolk series. They usually overlie reddish, micaceous heavy sandy loam or loam subsoils, which become coarser, looser, and more incoherent at about 30 inches. The soils occupy river terraces in the higher part of the Coastal Plain near the Piedmont Plateau boundary. They generally have a level or gently undulating surface, are fairly well drained, possess a subsoil retentive of moisture, and have a relatively high agricultural value.

Area and distribution of the soils of the Wickham series.

Soil name.	State or area.[1]	Acres.
Wickham sand	Virginia 6	4,416
coarse sand	North Carolina 15	2,816
sandy loam	North Carolina 15; Virginia 6	10,368
loam	Virginia 5	5,952
clay loam	Virginia 6	2,176
Total		25,728

[1] For key to numbers in this column see p. 733.

Yazoo series.—The color of the surface soil ranges from gray, slightly darkened with organic matter, to light brown, while the subsoils are of mottled grayish, rusty brown, and sometimes bluish. In the heavy types the material is somewhat plastic. The soils predominantly contain a high percentage of very fine sand. The series is developed in the flood plains of the Mississippi River as natural levees near the stream fronts and as slight ridges near the water front. The soils constitute the best drained types of the flood plains, some portions of them standing above water when the lower back country is inundated. They are usually sandy along the river, becoming heavier back toward the low country, and finally grading into clay soils, such as the Sharkey. The Yazoo soils are well suited to vegetables, such as cabbage, onions, garden peas, lettuce, Irish and sweet potatoes, cucumbers, melons, etc. Cotton, corn and forage crops also give good results, especially on the moderately heavy types.

Area and distribution of the soils of the Yazoo series.

Soil name.	State or area.[1]	Acres.
Yazoo fine sand	Louisiana 4, 6	11,200
sandy loam	Illinois 2, 9, 10; Indiana 8; Kansas 1; Louisiana 7, 11; Mississippi 19, 21.	97,083
fine sandy loam	Louisiana 4, 6; Mississippi 6	33,088
very fine sandy loam	Louisiana 4; Mississippi 1	45,440
loam	Illinois 1, 7, 9; Kansas 1, 4; Louisiana 6, 7, 11; Mississippi 6, 19, 21; Missouri 4, 14, 18.	204,803
silty clay loam	Louisiana 4	21,248
Total		412,862

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The soils of the sand group occupy a small total area in the River Flood Plains province. They occur as inextensive patches, usually in the natural levees near the stream banks, and in slight hummocks or swells through the bottoms of the smaller streams. They also have a scattered development over the terraces.

These are the lightest-textured soils of the province, and consequently are the least retentive of moisture. Unless fertilized and liberally supplied with vegetable matter, the yields average low. These soils, however, particularly those of the first bottoms, are generally a little more productive than the sands of the uplands, for the reason that they are usually more loamy, not having been so completely weathered and leached, a larger percentage of the fine material remaining throughout the soil mass than in case of the sands of the uplands, which generally have had the main portion of the fine particles washed out by erosion.

These sands are the earliest trucking soils of the River Flood Plains province, but owing to their rather scattered occurrence and to the liability of overflow in case of the first-bottom types, they have not been used to any considerable extent for trucking. They have been used, particularly the second-bottom types, for general farming, giving usually light to moderate yields.

The Kalmia sand seems to be the most extensive. It occurs on stream terraces, and is the least productive member of the group so far mapped. This particular type has about the same agricultural value as the Norfolk sand, which it quite closely resembles. It averages a little more productive than the Norfolk sand, probably because it is a little more retentive of moisture.

The Thompson sand has about the same characteristics as the Kalmia, but is confined to the first bottoms, where it is subject to overflow. It has a limited extent, being most prominent in the stream bottoms of Alabama and Mississippi.

The Cahaba and Wickham sands represent terrace types which are fairly well suited to corn, forage crops, oats, and vegetables. These are more productive than the ordinary upland soils of a sand texture.

The Ocklocknee sand, representing a first-bottom type of the Coastal Plains region, is quite variable in character, some areas being loose in structure and unproductive, while others are rather loamy and fairly well suited to corn and forage crops where overflows are not too frequent.

The Sarpy sand, which occurs in the bottoms of the Mississippi River and the streams of the loessial regions of the North Central States, gives moderate yields of general farm crops and is very well suited to the production of melons, potatoes, cabbage, and a number of other vegetables.

Cahaba sand.—The soil is a light-brown to brown rather loamy sand. The subsoil is a light-brown or yellowish-brown loamy sand, in which the content of silt and clay increases with depth, the lower portion frequently having a reddish cast. The substratum is a reddish-brown sandy loam, sometimes grading into a sandy clay somewhat similar to the Orangeburg subsoil. The type occupies comparatively high terraces and has an undulating surface configuration. Its drainage is mainly good. It is a good agricultural soil, producing under good management as much as one bale of cotton per acre. Corn, forage, oats, and a number of vegetables do well.

Dunning sand.—The soil is a black medium sand about 12 inches deep, and overlies a subsoil of grayish or somewhat mottled yellow and gray sand. The topography is level and usually low, some of the type occupying positions intermediate between Peat and surrounding terrace or upland soils, while other areas border stream courses. The water table is high and the natural drainage is poor, so that the type is too wet for cultivation of ordinary farm crops. Its chief use is for the production of wild marsh hay and for pasture. Some cultivated crops, such as corn, buckwheat, and potatoes, are grown in dry seasons.

Genesee sand.—To an average depth of about 8 inches the soil is a loose, incoherent sand of medium texture and light-brown or grayish-brown color. The subsoil is a yellowish loose sand, sometimes containing small amounts of gravel. The topography is level or slightly undulating where the soil has been drifted by the wind. The type is alluvial in origin, occurring as first bottoms along streams. It is subject to more or less overflow. Where well drained, and sufficient organic matter has been added in the form of barnyard manure or green crops turned under, the type is suited to some of the earlier vegetable crops. Corn can also be grown, though much of the land is best adapted to pasturage.

Kalmia sand.—The soil to an average depth of 10 to 12 inches is a medium to nearly coarse sand. Uncultivated areas are usually dark in the first few inches, owing to a rather high content of organic matter. The subsoil consists of a yellowish loose sand to loamy sand. The type occurs on level or slightly undulating high stream terraces lying above normal overflows. The material was deposited from overflow water before the stream channels were lowered to their present levels. Low yields of cotton, corn, and sugar cane are secured. Vegetables could be successfully grown with fertilization.

Myatt sand.—The soil grades from a dark-gray loamy sand at a depth of 4 to 5 inches into a light-gray loamy sand, which becomes heavier with depth until the subsoil proper is encountered at a depth of 18 to 20 inches. The subsoil is a mottled gray, red, and yellow, moderately stiff, plastic sandy loam to sandy clay. The type occupies low-lying, poorly drained areas upon the higher stream terraces. When drained and carefully treated, oats, corn, and forage do well.

Ocklocknee sand.—The soil to a depth of 8 inches is a dark-gray or light-brown medium to fine sand, rendered somewhat loamy by organic matter. The subsoil consists of medium to fine sand, varying in color from light gray to yellow. The soil is alluvial, and occupies a level position 10 to 15 feet above the river, but may be overflowed at times. It is well drained, and most of it is cultivated to general farm crops.

Sarpy sand.—The soil consists of a brownish-yellow to yellowish-brown light sandy loam to rather loose sand about 4 to 8 inches deep. The subsoil is a loose sand, faintly mottled with shades of yellow and brown. In typical areas the sand continues to a depth of 3 feet or more, but in some cases silty clay loam to clay is encountered in the lower portion of the soil section. This soil also occurs in a mixed phase with the Sharkey soils. Such "mixed land" is marked by hummocks or small mounds ("wind blows") of Sarpy sand, with intervening depressions of Sharkey soils in such complex arrangement that a separation would be impracticable and without value. The hummocks

are more or less rounded in shape and range from 8 to 15 inches above the bottoms of the depressions. Between the typical Sharkey clay in the center of the depressions and the typical Sarpy sand in the center of the mounds there are frequently gradational types or phases of these soils. The uneven surface configuration of such areas interferes with cultivation, but they are used for agricultural purposes. The typical Sarpy sand is of rather low agricultural value, being deficient in humus and irretentive of moisture. With the liberal addition of organic matter, such as barnyard manure and green crops plowed under, and with liberal use of fertilizers, good crops of melons, sweet potatoes, Irish potatoes, and a number of vegetables can be secured. The general farm crops ordinarily give poor results where the depth to clay is 3 feet or more.

Thompson sand.—This is a light-gray to nearly white sand occurring in the first bottoms of streams in situations favoring frequent overflow. Owing to the type's limited extent and unfavorable situation, it is of little importance. The material is so loose and so deficient in organic matter that any kind of agricultural utilization would generally necessitate liberal use of organic and mineral manures.

Wickham sand.—The soil is a dark-brown to yellowish-brown coarse sand from 16 to 26 inches deep, generally coarser in texture and lighter in color below 14 inches. The subsoil is a reddish-brown or yellowish, incoherent sand to light sandy loam, which grades at from 28 to 40 inches into a coarse, gravelly material. The type occurs along the rivers, occupying level or slightly sloping terraces. The drainage is good and in some of the coarser phases it is excessive. The soil is derived from Pleistocene deposits. General farm crops are the principal products grown, and fair yields are secured.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Kalmia sand	Alabama 1, 2, 9, 12, 14, 32; Georgia 2; Mississippi 20	56,768
Cahaba sand	Alabama 32; Mississippi 5, 10	17,792
Sarpy sand	Missouri 15	16,384
Dunning sand	Wisconsin 7	5,952
Myatt sand	Alabama 2, 9	5,184
Wickham sand	Virginia 6	4,416
Thompson sand	Mississippi 20	3,328
Ocklocknee sand	Alabama 27; Mississippi 9	2,496
Genesee sand	Wisconsin 3	512
Total		112,832

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

The coarse sands are inextensive in the River Flood Plains province, only two types having been mapped—the Kalmia and the Wickham. These are terrace soils of a loose nature and of rather low agricultural value. Vegetables, melons, and forage crops, such as cowpeas, do fairly well, especially with liberal fertilization, particularly with those fertilizers which contain relatively high percentages of nitrogen and potash.

Kalmia coarse sand.—The soil is a light-colored, rather loose coarse sand. The subsoil is a gray to pale-yellow coarse sand having about the same texture as the soil. The type occupies second terraces. Its moisture conditions are chiefly controlled by elevation, the nearness of the water table to the surface insuring a fair supply of moisture in flat areas and depressions and along the foot of slopes. Vegetables and forage crops do fairly well where the soil is liberally manured.

Wickham coarse sand.—This is a brown to reddish-brown, loose coarse sand, underlain at about 6 inches by a yellowish-brown or reddish-brown coarse sand. The type is developed on stream terraces and in river bottoms as slight knolls and ridges or swells standing above normal overflow. The material is largely from the Piedmont. The type stands above the frequently overflowed first-bottom soils. It gives good results with watermelons, and fair crops of cotton and corn with fertilization.

Area and distribution of the coarse sands.

Soil name.	State or area.[1]	Acres.
Kalmia coarse sand	Alabama 2	5,184
Wickham coarse sand	North Carolina 15	2,816
Total		8,000

[1] For key to numbers in this column see p. 733.

LOAMY-SAND PHASE.

Only one type of the phase group of loamy sands, the Cahaba loamy sand, has been mapped. It is a terrace type, which with good drainage and fertilization gives good results with potatoes, melons, and forage crops. Cotton, corn, and oats do fairly well. The soil is considerably more productive than the corresponding sand type, owing to a higher content of fine material, and the consequently greater retentiveness of moisture.

Cahaba loamy sand.—This is a grayish-brown sand underlain at an average depth of about 10 inches by reddish-brown loamy sand. The type is developed on stream terraces above normal overflow. Its drainage is good, yet moisture is conserved in amounts favorable to healthful plant development under ordinary conditions. Sweet potatoes, melons, forage crops, cotton, and corn do fairly well.

Area and distribution of the loamy sand.

Soil name.	State or area.[1]	Acres.
Cahaba loamy sand	Mississippi 5, 20	18,240

[1] For key to numbers in this column see p. 733.

FINE SAND GROUP.

While a large number of types having the texture of fine sand are found in the River Flood Plains province, the total area is small as compared with the extensive groups of loams, silt loams, and clays. According to the surveys made, however, a considerably larger area is occupied by the fine sands than by the sands.

These are loose-structured soils, easy to work, but not so easy to maintain in a good state of productivity, since they are generally rather irretentive of moisture and do not show lasting effects from the application of manures. They are, however, more productive with the same degree of treatment than the coarser sands of the province and similar-textured soils of the uplands. For the maintenance of the best state of productivity it is necessary to apply liberal amounts of vegetable matter, while good yields are generally not secured without moderate applications of commercial fertilizers, particularly those containing relatively high percentages of nitrogen and potash.

One of the biggest problems encountered in the utilization of those types occurring in the overflowed bottoms is to secure proper protection from overflow and to establish necessary underdrainage. The terrace members of the group not being subject to overflow, or at least to frequent overflow, are generally much better drained, but these are prevailingly more deficient in organic matter, and, outside of the work involved in the establishment of good drainage, require more intensive treatment.

These soils are best suited to the production of melons, sweet potatoes, Irish potatoes, vegetables, forage crops, sugar cane, cotton, corn, and oats. In some sections certain types of tobacco are produced with a fair degree of success. They are not quite so early as the coarser sands, but are much better suited to the production of medium early truck crops than the heavier soils of the province.

The most extensive types are the Myatt fine sand of the overflowed bottoms of the Coastal Plain, the Miller fine sand of the first bottoms of streams rising in the Red Beds region, the Kalmia fine sand of the well-drained terraces of the Coastal Plain region, and the Wabash fine sand of the overflowed bottoms of

the streams rising in and issuing from the loessial regions of the North Central States.

Cahaba fine sand.—The soil to a depth of 10 to 12 inches consists of a grayish-brown loamy fine sand. This is underlain by a reddish-brown or dull-red loamy fine sand extending to a depth of 30 inches or more. Between 30 and 40 inches a stiff reddish-brown clay may be encountered. Mica flakes are present in both soil and subsoil. The type is alluvial in origin and occurs mainly as long, narrow ridges in the second bottoms of the large streams in the Coastal Plain of the Gulf States. It is, on account of the open, loose nature of the component material, somewhat droughty. The original timber growth consisted principally of pine, oak, sweet gum, and poplar. The yields of cotton, corn, and oats are rather light.

Chastain fine sand.—The soil is a light-gray fine sand of low organic-matter content. The subsoil is a gray fine sand, usually faintly mottled with yellowish or brownish colors and water-soaked in the lower portions. The type occupies first bottoms lying at a somewhat higher elevation and averaging much more uniform in textural features than Meadow. It usually supports a rather scattered growth of pine. The soil has a poor, lifeless appearance and is of little agricultural value.

Congaree fine sand.—The soil is a grayish-brown to chocolate-brown fine sand to loamy fine sand about 6 to 10 inches deep. The subsoil is of about the same texture as the soil, but somewhat darker in color. At about 36 inches fine sandy loam to silty clay is encountered. The type is developed usually as slightly elevated natural levees along stream fronts. It is subject to overflow, though generally not so much as the lower-lying alluvial soils back from the streams. It is an excellent agricultural soil, producing in the more loamy areas from 25 to 90 bushels of corn, 40 to 60 bushels of oats, and from three-fourths bale to 1½ bales of cotton per acre.

Genesee fine sand.—The soil is a light-brown or grayish-brown, rather incoherent fine sand, about 8 inches deep, and overlying a yellowish fine sand. The topography is flat to gently undulating and the soil is subject to wind action. The type is alluvial in origin and occupies first-bottom positions along streams. The natural drainage is good, though the type is subject to overflow, and its agricultural value is low. Where flooding can be prevented fair crops of corn and grass may be grown.

Huntington fine sand.—The soil is a dark reddish-brown loamy fine sand, overlying a reddish-brown fine sand or fine sandy loam. The alluvial material of this type is of recent deposition and often contains more or less finely divided mica. The soil is of too light texture for general farm crops, and on account of this and its liability to overflow it is best adapted to hay and pasture.

Kalmia fine sand.—The soil is a grayish to light-brown fine sand, averaging 5 or 6 inches in depth. The subsoil is a yellowish fine sand, which usually becomes lighter in color below 30 inches. Owing to a high content of very fine sand in both soil and subsoil, the entire soil mass is inclined to become compact. The type is alluvial in origin and occupies terraces and the higher bottom land lying mainly above normal overflow. The soil is easily cultivated and under proper management gives better yields than somewhat similar upland fine sand. Corn, forage crops, melons, potatoes, and a number of vegetables do well.

Lintonia fine sand.—The type consists of a dark-gray to brown fine sand, which at a depth of 10 to 12 inches is underlain by grayish to light-brown fine sand. It occupies second terraces, of billowy topography. It has good drainage and lies mainly above normal overflow. The material is derived from loessial uplands. The yields of ordinary farm crops are light, but the type is well suited to strawberries and other small fruits and truck.

Miller fine sand.—The type consists of a loose, loamy, gray to reddish-gray fine sand. The subsoil is a loose, reddish fine sand, extending to a depth of several feet. It is a first-bottom soil, alluvial in origin and usually well drained. It is used principally for corn and cotton and fair yields are produced. The higher lying areas are adapted to fruit, especially peaches. Vegetables also do well, but are grown only for home consumption.

Myatt fine sand.—The type consists of 6 to 10 inches of gray or drab fine sand, generally underlain by a mottled gray and yellow silty fine sand extending to a depth of 20 inches. Below this the subsoil varies from a mottled gray and yellow silty fine sand to sticky fine sand. The soil is alluvial in origin. In places it is darkened by large amounts of organic matter. Natural drainage is poor and but little of the type is in cultivation.

Ondawa fine sand.—The soil, from 4 to 6 inches deep, is a light-brown to yellowish fine sand. The subsoil has the same texture as the surface soil, although it is usually somewhat lighter in color. The type occurs either as a deposit from flood waters in slightly undulating areas from moderately swift currents or as small deltas built out on the flood plains by small streams coming down from sandy soils of the higher terraces or uplands. It is always of recent or present alluvial origin. The type is adapted to corn, potatoes, and early truck crops.

Papakating fine sand.—The soil is a dark-brown to black fine sand, averaging about 9 inches in depth. The subsoil ranges from brown to gray in color, and varies somewhat also in texture, but is usually a fine sand, which not infrequently grades into a heavy sandy loam or even clay subsoil at the lower depths. No stone or gravel of noticeable extent occurs in either soil or subsoil. The topography is level or slightly undulating, the type occupying first-bottom positions along streams. The land is subject to annual or periodic overflow. Drainage is poor in areas of depression. The origin of the material is principally alluvial, though in some areas, the subsoils at least, may be in part lacustrine material previously laid down in the old glacial lakes. Where the drainage is sufficient to remove the surplus water or where artificial drainage is installed the type is well adapted to the production of early cabbage, lettuce, sugar beets, cauliflower, and early Irish potatoes. It is not so well adapted to the general farm crops.

Sarpy fine sand.—The soil is a light-brown to grayish-brown fine sand, sometimes containing minute but visible mica flakes. The subsoil is a yellowish-brown fine sand, in places faintly mottled with shades of brown. The soil is typically developed on natural levees along stream courses and bayous. It is highest nearest the stream front, sloping gradually away to blend with heavier types. Cotton, corn, oats, cowpeas, and a number of vegetables do fairly well, especially where the organic matter content is maintained and the soil occasionally manured or fertilized.

Teller fine sand.—The soil has a depth of about 10 inches. It is a medium fine sand, containing considerable organic matter, which gives it a gray color. The subsoil, to a depth of 36 inches or more, is of similar material, but lacks organic matter and has a yellow color. On some parts of the type in river bends the soil is light red in color, and there is no perceptible difference between the soil and subsoil. The type is found entirely in the bottom lands and consequently has a nearly level surface. It is sedimentary in origin, having been laid down by stream waters when they occupied a much higher stage than at the present time. The principal crops grown are cotton and corn, but only fair yields are obtained. The soil is well adapted to potatoes, melons, and other truck crops, and a number of fruits. Better returns can be obtained from these than from the staple farm crops.

Wabash fine sand.—This consists of a loose fine to very fine sand, 3 feet or more in depth. The surface soil, which is from 6 to 8 inches deep, ranges from light gray to brownish gray. The subsoil has a yellowish or light-brown color and is less coherent than the soil. The type occurs as an alluvial deposit in the first-bottom stream courses. It is used to some extent for general farming, but is particularly adapted to trucking.

Wheeling fine sand.—The soil to a depth of about 11 inches is a loose, brown fine sand. The subsoil to a depth of over 3 feet is a brownish-yellow sand of practically the same texture as the soil, becoming slightly lighter in color as depth increases. The type occupies gently to sharply rolling areas and is composed of earlier deposits of the Ohio River, which have later been subjected to the action of wind. This has given to the type its present topography. The crops to which the soil seems to be best adapted are watermelons and tomatoes. Fairly good crops of potatoes, corn, wheat, rye, and cowpeas are also produced during favorable seasons. Small fruits, such as strawberries and blackberries, seem to do well on this type.

Yazoo fine sand.—To a depth of 36 inches this is a gray, incoherent sand consisting of quartz and feldspar and possessing a uniformly fine texture. While the surface soil occasionally contains a small amount of organic matter, the material usually shows an incoherent structure throughout the profile. The type occupies relatively small, disconnected areas along the immediate banks of the Mississippi River, and occurs when recent breaks in the loess result in a sudden checking of the swifter currents, with consequent deposition of the coarser particles of the suspended sediments. The type is not at present used for agricultural purposes.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Myatt fine sand	Alabama 2, 5	67,520
Miller fine sand	Arkansas 3; Louisiana 3; Texas 23, 24, 31	66,944
Kalmia fine sand	Alabama 9, 12, 32; Mississippi 5	32,320
Wabash fine sand	Indiana 1; Oklahoma 1	16,064
Yazoo fine sand	Louisiana 4, 6	11,200
Cahaba fine sand	Alabama 2, 18; Mississippi 3, 5, 14	6,912
Genesee fine sand	Wisconsin 3	5,504
Huntington fine sand	Alabama 3; Arkansas 1	5,376
Wheeling fine sand	Ohio 6; West Virginia 2, 6, 7	4,800
Chastain fine sand	Alabama 2	4,672
Lintonia fine sand	Illinois 3, 7; Missouri 14	4,352
Papakating fine sand	New York 5	3,904
Ondawa fine sand	New York 17	2,176
Congaree fine sand	North Carolina 23	2,112
Teller fine sand	Oklahoma 2	1,344
Sarpy fine sand	Missouri 10	1,280
Total		236,480

[1] For key to numbers in this column see p. 733.

VERY FINE SAND PHASE.

Only two types having the texture of very fine sand have so far been mapped. Soils of this texture probably will not be encountered in sufficiently extensive areas to constitute an important group. On account of their finer texture, they are more retentive of moisture and somewhat more productive than the fine sands. They are suited to about the same crops.

Osage very fine sand.—The soil is a loose, incoherent, light-brown to gray very fine sand, overlying a very fine sand of lighter color. The soil is porous, and drainage is free. It is subject to wind action, and as a result the topography is often hummocky. The type usually occurs along the channels of moderately large streams deriving their sediments from the residual soils from sandstone, shale, and limestone of the upland prairie region. The soil is most useful for the production of special types of vegetables, such as melons, asparagus, and sweet potatoes.

Sarpy very fine sand.—The soil consists of a light-brown or grayish-brown very fine sand of rather loamy nature, frequently containing numerous small flakes of mica. The subsoil is a light-brown, rather incoherent very fine sand to a depth of 3 feet or more. The type occurs as natural levees along large streams. Its topography is ridgy or undulating. The agricultural value of the soil is not great, but it has a limited usefulness for certain vegetables and such crops as corn and oats.

Area and distribution of the very fine sands.

Soil name.	State or area.[1]	Acres.
Osage very fine sand	Kansas 9	36,544
Sarpy very fine sand	Kansas 5; Missouri 16	4,544
Total		41,088

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

The sandy loams of this province comprise a moderate area, being fairly extensive in some of the first bottoms, especially in higher situations along the stream fronts, and in the narrow bottoms of small streams where the regional uplands include large areas of sandy land.

These soils are easy to work, on account of their light texture, and require light tools and stock. The terrace members of the group are in need of organic matter, such as can be advantageously supplied by growing and plowing under crops like cowpeas, clover, and rye. Commercial fertilizers, particularly those

containing relatively high percentages of nitrogen and potash, in moderate applications, can be used profitably on the terrace types.

The soils under proper climatic conditions are well suited to the production of vegetables, particularly potatoes, cucumbers, tomatoes, and melons. Where proper drainage and protection from overflow can be established the first-bottom soils give good results with the general farm crops adapted to the climate, sugar cane, corn, oats, and forage crops giving excellent yields. Owing to the fact that crops reach maturity earlier on the sandy loams than on the heavier bottom lands, cotton is better able to withstand the ravages of the boll weevil on soils of this texture than on heavier types.

The surface portion of the first-bottom members of this group usually contains considerably more fine material than the sandy loams of the uplands, particularly those of the Coastal Plain. They therefore average more productive under good drainage conditions than the sandy loams of the Coastal Plain region. The terrace sandy loams approach more nearly the characteristics of the upland sandy loams and are quite similar to the latter in crop adaptation and value, although they average generally a little more productive.

The most extensive types of the group are the Yazoo sandy loam of the Mississippi bottoms, the Congaree sandy loam of the first bottoms along streams flowing through and issuing from the Piedmont region, and the Myatt, Cahaba, and Kalmia sandy loams of the Coastal Plain stream terraces.

Altavista sandy loam.—The soil is a gray sandy loam with an average depth of about 10 inches, carrying a fair percentage of rounded pebbles and cobbles scattered over the surface and throughout the soil. The subsoil is a mottled yellow and red clay loam, which in the lower portion grades into red clay, occasionally slightly mottled with yellow. The type occupies the more gradual slopes of valley walls adjoining stream bottoms and occasionally rather indistinct old terraces. Former river action contributed a part of the component material, while some of it appears to have been washed down from contiguous slopes. Part of the soil and most of the subsoil material seems to be of residual origin. Tobacco, corn, wheat, oats, and grass are grown with fair results.

Amite sandy loam.—The soil to an average depth of about 10 inches is a brown or reddish-brown sandy loam to loamy sand of the same color. The subsoil varies from a heavy red sandy loam to a sandy clay. The surface is gently rolling and the type is sometimes spoken of as "second-bottom" or "hammock land." It is sedimentary in origin. The soil is adapted to corn, cotton, oats, sweet and Irish potatoes, and sugar cane, and is also suited to truck crops.

Aroostook sandy loam.—The soil to a depth of 6 to 12 inches consists of a brown or yellowish-brown medium to fine sandy loam. The subsoil is a grayish-black or greenish-gray medium sand containing small particles of quartz, calcite, and mica, but consisting principally of dark-colored shale, slate, and sandstone fragments. Pockets of a light-colored silty sand are of frequent occurrence in the subsoil. At about 36 inches a rather impervious, compact stratum of clay is encountered. On the upland side the type frequently grades by degrees into the Caribou loam. The type occupies level or ridgy second terraces and consists of reworked material. It retains a fairly good supply of moisture, but some crops, such as oats and grass, are apt to suffer in prolonged droughts. The native vegetation was ash and elm. The soil is used for potatoes, oats, and grass, producing moderate yields. Vegetables could be successfully grown.

Bastrop sandy loam.—The soil to a depth of from 10 to 24 inches is a grayish-brown to reddish-brown light sandy loam. The medium and fine grades of sand predominate. The subsoil to 36 inches is a reddish to dark-reddish sandy clay, the lighter color occurring on the more elevated and better drained areas. The type is the oldest of the alluvial bottoms. It occupies the highest swells and terraces of the alluvial area, much of the finer material having been washed to the lower levels, leaving a more open structured and sandier soil. The red sandy clay subsoil represents material of the old Permian Red Beds reworked by river action. The topography in general is rolling, and drainage is good. The soil is suited to the cultivation of cotton and corn, though corn gives better results on the lower alluvial soils. It is especially adapted to small fruits, grapes, melons, potatoes, and truck crops. The maintenance of organic matter is essential.

Bibb sandy loam.—This soil is a nearly white to ashy-gray, moderately coarse sand, underlain by somewhat plastic sandy clay of a grayish color frequently mottled with yellowish. It occupies first bottoms of streams, where it was formed as an alluvial type. It is subject to frequent overflow and is poorly drained. Grasses give better results than other crops.

Cahaba sandy loam.—This type to a depth of 12 inches consists of a medium to fine reddish-brown loamy sand to sandy loam. The subsoil is typically a reddish-brown, stiff, heavy clay. Some of the older, better-drained areas have a bright-red subsoil. It is an alluvial type occurring in the second bottoms of the major streams in the Coastal Plain of the Gulf States. It is well suited to the production of cotton, corn, oats, and peanuts.

Congaree sandy loam.—The soil consists of a grayish-brown to reddish-brown sand to light sandy loam 8 to 12 inches deep. The subsoil is a dark-gray to brown or reddish-brown sandy loam, often mottled with yellow or brown. There may be some variation in the subsoil in the form of an occasional bluish color or mottling and layers of sand or sandy loam alternating with similar layers of loam or silt loam. The type occupies first bottoms and is derived largely through wash from the Cecil soils. It is subject to overflow. In dry years or when protected from overflow corn, oats, sugar cane, sorghum, and certain vegetables do well.

Cumberland sandy loam.—The soil consists of a brown, mellow sandy loam. The subsoil is a light-brown or reddish-brown loam to fine sandy clay. The type occupies nearly level to gently rolling second terraces and has good drainage. It is quite productive, being especially suited to corn, grain, and a number of vegetables.

Genesee sandy loam.—The soil of this type is a yellowish-brown sandy loam about 9 inches deep, overlying a light-brown or yellowish sandy loam subsoil. Stratified sand and fine gravel frequently appears in the subsoil and sometimes extends to the surface. The type occupies usually level areas in the first bottoms of streams, and is subject to more or less overflow. The soil is easily cultivated and is adapted to corn, oats, hay, and potatoes.

Huntington sandy loam.—The soil to a depth of 6 or 8 inches is a dark-brown to black light loam to sandy loam. The subsoil is a drab to black heavy silt loam or clay loam. Both soil and subsoil carry varying amounts of gravel and rounded stone fragments. The type has been formed from material washed from the limestone, sandstone, and slate uplands and deposited in the first bottoms of streams. It is adapted to the general farm crops. Grass does particularly well.

Kalmia sandy loam.—The soil is a gray to brown sandy loam of medium texture, overlying a yellow to slightly reddish sandy clay frequently mottled with gray. It occurs on the first and second terraces along the Alabama River and some of its tributaries, and is of alluvial origin. It requires drainage and is sometimes inundated during rainy periods The type is best suited to corn and grass. It is sometimes used for cotton.

La Crosse sandy loam.—The soil is a dark-brown to black medium sandy loam about 10 inches deep. The light-brown subsoil is of somewhat lighter texture than the soil and grades into a yellowish, rather incoherent sand at about 3 feet. The type occupies a terrace position and the topography is usually level, although the outer edges of some of the areas slope slightly upward to merge with the upland types. Drainage is good, but seldom excessive. The type is used for such staple crops as corn, barley, and potatoes, fair yields being secured. It is also in use to some extent for the production of truck crops.

Myatt sandy loam.—The Myatt sandy loam consists of a gray to dark-gray medium to fine sandy loam, and overlies grayish material varying from heavy sandy loam to sandy clay. At a depth of about 3 feet the material grades into a stiffer and more plastic substratum. The type occurs on the river terraces in poorly drained, flat or depressed areas. It is regarded as a cold-natured soil, very difficult to handle in its natural condition. When properly drained and cultivated vegetables do fairly well. Johnson and Bermuda grasses yield from 2 to 3 tons per acre. Corn, oats, and sugar cane succeed moderately well.

St. Catherine sandy loam.—The soil to a depth of about 10 inches is a medium to rather fine sandy loam or sand of yellowish color. The subsoil consists of about the same material, though occasionally grading into sticky sandy loam at 30 inches. Gravel is usually present in both soil and subsoil. The type occurs along the foot of loess bluffs as narrow strips having a gentle slope toward the contiguous true alluvium. It is derived from outwash material from exposure of the Lafayette and Port Hudson formations modifying the loess, and includes very little loessial material. The soil is inclined to be droughty. Early vegetables are the most successful crops.

Trinity sandy loam.—The soil to an average depth of about 12 inches consists of a dark-brown sandy loam to heavy sandy loam. The subsoil is quite variable, but usually consists of dark-brown to black loam or sandy clay. The type occurs in stream bottoms, generally near the outer margins where there has been more or less accumulation of material from adjacent uplands. The main portion of the component material is derived from the calcareous prairies. Drainage is good, except for occasional overflow. Cotton, corn, sugar cane, forage crops, and a number of vegetables do well.

Tyler sandy loam.—The soil to an average depth of about 10 inches consists of a brown to dark-brown medium sandy loam. The subsoil is a brownish-yellow or rather heavy sandy loam of uniform characteristics to a depth of at least 3 feet. The type occupies second bottoms of the larger streams, having been washed from near-by upland areas of sandstone soil. It lies above the level of normal overflows. The type, while not naturally a highly productive soil, is susceptible of ready improvement. The average yield of corn is about 25 bushels, but much larger yields are secured under proper management. Fair yields of wheat, oats, and buckwheat are secured. Sweet potatoes and truck crops, such as potatoes, asparagus, onions, lettuce, and cabbage, do well. Good yields of certain varieties of apples and strawberries are secured.

Wabash sandy loam.—The soil to a depth of from 12 to 24 inches consists of a dark-brown to reddish-brown sandy loam of rather coarse texture, becoming lighter in color with depth. This is underlain by a yellowish coarse sandy loam, coarse sand, or stratified gravel, Generally large quantities of gravel are distributed throughout the soil profile. The type occupies strips along river and stream bottoms and is generally subject to overflow. It is usually well drained. The principal crop is corn. The soil is also well suited to melons, sweet potatoes, cabbage, and other truck crops.

Wheeling sandy loam.—The soil consists of about 8 inches of light-brown sandy loam, resting upon a rather incoherent yellowish sandy loam to loamy sand, which extends to a depth of 3 feet or more. Quartz and other pebbles occur upon the surface and throughout the soil and subsoil. The type is confined to river terraces and has a gently rolling topography. It is composed of reworked material brought from the glacial region to the north by river currents when flowing much stronger than at present. The surface material of the earlier deposition has been somewhat modified by the accumulation of organic material. Practically the whole of the type is devoted to the growing of apples, for which purpose it seems best adapted.

Wickham sandy loam.—The soil is a reddish-brown or brown loamy sand to light, friable sandy loam, ranging in depth from 10 to 26 inches. The subsoil is a reddish sandy loam or loam, sometimes containing mica, and grading into a heavy sandy loam or sandy clay, also containing mica. The type occupies terraces, part of which are overflowed. The surface is level or nearly so, but drainage is fairly good. This is a desirable soil for general farm crops.

Yazoo sandy loam.—The soil is a gray to brown fine sandy loam 6 to 12 inches deep, underlain by sandy loam of a lighter color, often mottled with brown, gray, and blue. It has been deposited by streams, usually upon a clay foundation, which in some cases comes within 12 inches of the surface. The type occupies low, flattish ridges forming front lands near stream courses in river bottoms. The chief product is cotton, but the soil is suited to truck and market garden crops. Corn and truck do well in the northern areas.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Yazoo sandy loam	Illinois 2, 9, 10; Indiana 8; Kansas 1; Louisiana 7, 11; Mississippi 19, 21.	97,083
Kalmia sandy loam	Alabama 1, 8, 14; Georgia 2, 15	48,192
Congaree sandy loam	Alabama 7	43,648
Myatt sandy loam	Alabama 1; Georgia 17	36,032
Cahaba sandy loam	Alabama 8, 18, 31, 32, 37; Mississippi 5	32,960
Wickham sandy loam	North Carolina 15; Virginia 6	10,368
Bastrop sandy loam	Texas 3	7,680
Amite sandy loam	Louisiana 13	7,232
Huntington sandy loam	Alabama 14, 15; Pennsylvania 5	6,784
Wabash sandy loam	Indiana 10; Ohio 7	6,624
Bibb sandy loam	Alabama 8, 32	4,352
Trinity sandy loam	Texas 14	2,688
Wheeling sandy loam	West Virginia 4, 7, 10	1,920
La Crosse sandy loam	Wisconsin 9	1,856
St. Catherine sandy loam	Mississippi 1	1,280
Altavista sandy loam	Virginia 4	1,088
Aroostook sandy loam	Maine 1	960
Cumberland sandy loam	Kentucky 3	896
Genesee sandy loam	Pennsylvania 7	576
Tyler sandy loam	West Virginia 8	448
Total		312,667

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

Only one member of the gravelly sandy loam phase, the Holston gravelly sandy loam, has been mapped, and this only in small areas. Soil of this character is loose in structure and irretentive of moisture, with a rather low agricultural value.

Holston gravelly sandy loam.—This soil is a brown, medium to fine sandy loam, about 10 inches deep. Rounded quartz, chert, and sandstone gravel is scattered over the surface. The subsoil is a yellowish fine sandy loam or clay loam containing considerable fine gravel. The surface is nearly level to somewhat rolling, and knolls occur where the type is developed on high terraces. The type lies above overflow and was formed when overflows reached higher levels than at present. The soil is of rather low agricultural value.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Holston gravelly sandy loam	Alabama 6, 15	10,624

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams occupy an important area in the River Flood Plains province, being considerably more extensive, according to soil surveys thus far made, than the soils of sandy loam texture.

The fine sandy loams are easy to work and require only light tools and stock for the maintenance of a good condition of tilth. They are, particularly in case of the second bottom members of the group, generally in need of vegetable matter. The terrace types also give better yields when fertilized with moderate applications of commercial mixtures, especially those containing relatively high percentages of nitrogen and potash. The fine sandy loams of the first bottoms average considerably more productive than those of the terraces, having generally a higher percentage of fine material, silt and clay in the surface portion. They are, however, not so well drained as the second bottom soils, being subject to overflows and frequently to poor drainage conditions between overflows.

The soils of this texture give good results under proper drainage conditions with medium late truck crops, such as melons, cantaloupes, cucumbers, sweet

and Irish potatoes, and cabbage. The general farm crops give moderate to good yields, particularly on the first-bottom soils which are not subject to frequent overflow. Corn, oats, cowpeas, millet, sorghum, sugar cane, and cotton give fair to good yields on both the first and second bottom members of the group where the climate is favorable. In districts infested with the boll weevil these soils are used advantageously for cotton production on the heavier types, on account of their tendency to mature crops earlier.

The Miller fine sandy loam is the most extensive member of the group. This occupies relatively large areas in the first bottoms of streams flowing through and issuing from the Red Beds region. The Cahaba fine sandy loam also is an extensive soil on the terraces of the Coastal Plain, particularly in Alabama and Mississippi. The Ocklocknee member comprises a considerable total area in the first bottoms of the Coastal Plain, while the Myatt is fairly extensive in the poorly drained, and the Kalmia, in the moderately well-drained portions of the Coastal Plain terraces. The Wabash fine sandy loam has a fair development in the first bottoms of the streams flowing through and issuing from the loessial regions. The Holston fine sandy loam comprises moderate areas in the terraces of the Appalachian region. The Huntington fine sandy loam, consisting of Appalachian and Limestone material, occurs in rather small, scattered bodies in the overflowed bottoms of the Limestone and Appalachian provinces. The other types of this group have a widespread occurrence, but so far as the soil surveys have been extended they individually comprise relatively small areas.

Altavista fine sandy loam.—The soil is a gray fine sandy loam, underlain ordinarily at 6 to 10 inches by a compact, heavy fine sandy clay or clay loam of a pale-yellow or yellow color, slightly mottled with gray or shades of brown. The mottling is more pronounced in the poorer drained situations. The type is developed on stream terraces with prevailingly flat surfaces. Portions of it are overflowed in times of high floods, but none is so frequently inundated as the first bottoms. The material is largely from the soils of the Piedmont Plateau. Cotton, corn, and oats do fairly well. Grass and forage crops should give good results.

Austin fine sandy loam.—The soil is a brownish-yellow or reddish-gray fine sandy loam. There is no marked difference between the soil and subsoil, and the latter often extends to considerable depths without change. From the surface to a depth of about 3 feet the color gradually becomes lighter. The soil is of sedimentary origin, having been formed by the floods of the streams when they flowed at a higher level. Its surface is level, with an elevation of from 40 to 60 feet above the present level of the streams. The type is well drained and is inclined to be somewhat droughty. It is adapted to corn, cotton, fruit, and some vegetables. Considerable sorghum fodder is grown. Alfalfa can be successfully grown.

Bastrop fine sandy loam.—This type consists of 6 to 12 inches of dark-brown, medium to fine sandy loam, underlain by a brown fine sandy clay, which becomes lighter in color and heavier in texture with depth. It is an alluvial soil occurring on terraces, and has a comparatively level topography, with characteristic swells and depressions. The drainage is generally good, with the exception of some depressed areas, which demand surface ditching. The type is seldom overflowed. It is one of the most productive of the alluvial soils, and is adapted to a wide range of crops, including cotton, corn, sorghum, oats, alfalfa, and pecans, all of which do well.

Bibb fine sandy loam.—This type is a light-gray fine sandy loam, underlain by gray fine sandy clay mottled with yellow. The type represents first-bottom alluvial material derived principally from noncalcareous Coastal Plain soils. It is subject to frequent overflow. The soil needs drainage and applications of lime in order to be brought into proper farming condition. Lespedeza and a number of wild grasses flourish, affording good pasturage.

Cahaba fine sandy loam.—The soil to a depth of from 8 to 12 inches is a yellowish-gray to brownish-gray fine sandy loam, overlying a yellowish to reddish-brown heavier fine sandy loam to fine sandy clay, which is often mottled below 24 inches with light gray. The type is alluvial in origin and occupies the older and higher terraces along the larger streams in the Coastal Plain of the Gulf States. The topography is level to gently undulating, and, as a rule, the drainage is fairly good. The larger part of the type is above possibility of overflow, though some of it is inundated for short periods in years of excessive flood. In Alabama, Georgia, and parts of Mississippi large areas of this type are under cultivation. It forms one of the most important agricultural soils

for general farm crops and the heavier types of truck. It averages about one-half bale of cotton and 20 bushels of corn to the acre, but under improved methods of management these yields can be greatly increased.

Chastain fine sandy loam.—The soil consists of grayish and dark-gray fine sandy loam to fine sand, underlain at from 2 to 4 or 5 feet by an impervious, stiff clay, mottled drab, yellow, and red. The type occurs as broad, flat stream bottoms, and is for the most part subject to frequent overflow. None of this land is under cultivation, and the soil has the appearance of being rather unproductive. Along some of the lesser streams the drainage conditions are somewhat better, overflows being not so frequent, and the stiff clay subsoil is usually not so near the surface. Portions of these better drained stream bottoms could be brought under cultivation and could probably be made to produce fair crops of corn, oats, and forage.

Congaree fine sandy loam.—The soil is a brown or reddish-brown medium fine sandy loam or loam 3 feet or more in depth. In some areas the type tends to become sandier with depth, while in others the reverse is true. In places it is somewhat modified by colluvial wash from the uplands. The surface is generally level. The type occurs principally as first bottoms along swift-flowing streams and is subject to occasional overflow during very wet weather, but during the remainder of the year it is sufficiently well drained to produce excellent crops of corn, cotton, sorghum, and grasses. Cotton does best upon the higher and better drained areas.

Cumberland fine sandy loam.—The soil is a light-brown to yellowish silty fine sandy loam, 8 to 15 inches in depth. The subsoil consists of a thin layer of yellowish-red to red gritty clay or clay loam, which changes quickly into a dark-red, stiff clay. Occasionally rounded gravel occurs on the surface and in the soil. The type occupies rolling and sloping terraces along the larger streams, and has excellent drainage. The subsoil is often partly residual from limestone, while the soil represents ancient alluvium. Almost all of the soil is cultivated to general farm crops. It is adapted to strawberries and small fruits.

Elk fine sandy loam.—This is a grayish-brown fine sandy loam to heavy fine sandy loam, underlain at about 6 to 10 inches by a yellow or yellowish-brown fine sandy clay of moderately friable or brittle character. The type occupies flat to undulating stream terraces standing above overflow. On the higher, older terraces erosion has effected in places a gently rolling configuration. The soil under proper management conserves moisture well and gives good returns with general farm crops. Drainage is well established over the greater part of the type.

Frio fine sandy loam.—The Frio fine sandy loam, being partly colluvial in origin, differs from the soils adjoining it. Where the adjoining soil is Norfolk fine sand, the type consists of 18 to 30 inches of gray or dark-gray fine sandy loam or loamy fine sand, underlain by mottled gray and yellow waxy heavy clay. Sometimes it consists of terraces of brown to dark-brown fine sandy loam, overlying material of the same texture but more compact. When cultivated the soil is loose and powdery, but in its native state the surface is slightly packed.

Genesee fine sandy loam.—The soil consists of a light-brown to dark-brown, moderately heavy fine sandy loam from 10 to 20 inches deep. The subsoil has about the same texture as the soil, but is usually slightly lighter in color. There are in places slight variations from the typical soil, owing to local erosion and to deposition of sand and silt over small areas by overflow waters. Streaks of sand and silty material are sometimes encountered in the soil mass. Most of the type is subject to annual or frequent overflow. It is mainly a well-drained, mellow, friable soil, easy to till, and where protected from overflow it is admirably suited to corn, oats, clover, and timothy. Corn yields upward of 100 bushels, and oats from 50 to 60 bushels per acre. Cabbage, tomatoes, and other truck crops can be profitably grown.

Holly fine sandy loam.—The soil to a depth of 8 to 10 inches is a gray to almost white fine sandy loam. The subsoil is a sticky, plastic fine sandy clay to silty clay of a mottled gray and yellow color. The type is developed in the first bottoms of streams where it is subject to overflow. It is of alluvial origin, consisting of material washed from sandstone, limestone, and shale soils. There are areas where there has been some accumulation of colluvial material from slopes or from gulches issuing from the adjoining highlands. With proper drainage, corn, oats, and forage crops give fair to good results. In its natural condition the type is best suited to grass.

Holston fine sandy loam.—To a depth of about 10 inches the soil is a grayish to brown fine sandy loam, containing large amounts of silt. The subsoil is a yellow, heavy fine sandy loam, becoming reddish in the lower profile. The type occurs as high old terraces above overflow. Shales and interbedded limestone of the Conasauga formation often underlie this type at no great depth. The topography is level to gently undulating, permitting good natural drainage. The principal crops are cotton and corn. The yields are lower than on adjoining first-terrace soils.

Huntington fine sandy loam.—The soil is usually a light-brown to dark-brown fine sandy loam. It is yellowish-gray in color where more than the average amount of sand is present. The subsoil to a depth of 36 inches is of about the same texture, but lighter in color, though in places it contains considerable organic matter. In places the upper subsoil contains considerable fine material, which rapidly decreases with depth until, at about 30 inches, it becomes a fine sand of loose and incoherent structure. The type occupies first bottoms and owes its origin to sediments carried from the uplands. It is well adapted to both general farming and trucking.

Kalmia fine sandy loam.—The Kalmia fine sandy loam has a dark-gray to brown fine sandy loam surface soil 15 to 18 inches in depth, overlying a yellowish-gray, mottled, heavier fine sandy loam or sandy clay. The type is alluvial in origin and occupies high first and second terraces along Coastal Plain streams. The topography is nearly level to gently undulating, and, although the land is seldom overflowed, much of it is poorly drained, especially during periods of considerable rainfall. The native vegetation includes water oak, the gums, hickory, and pine. Some cotton is grown, but the type seems best adapted to corn.

La Crosse fine sandy loam.—The soil is a somewhat compact, dark-brown to black fine sandy loam about 10 inches deep, and overlies a subsoil of light-brown fine sandy loam, which grades into a yellow, rather incoherent fine sand at about 30 inches. The topography is level to gently undulating or dunelike where the soil has been blown by the wind. The type occupies a low terrace position, and natural drainage is for the greater part good. Fair returns are secured from the production of potatoes, sweet corn, and other truck crops. The soil is in need of lime and organic matter.

Leaf fine sandy loam.—The soil is a light-gray fine sandy loam, usually carrying a high percentage of silt. The subsoil is a compact, light-gray or mottled gray and yellow silty clay, grading downward into mottled red and gray or red and yellow plastic clay. The subsoil is too dense to admit of good aeration and free movement of moisture, being somewhat similar to those of the Susquehanna series both in structure and in color. The type is developed on stream terraces. It is used in a small way for the general farm crops with rather poor average results. In favorable seasons fair yields of cotton and corn are made when fertilizers are applied in liberal amounts.

Lintonia fine sandy loam.—The soil consists of yellowish-brown to dark-brown silty fine sandy loam, averaging about 10 inches in depth. The subsoil is a yellow to light-brown silty clay loam. The type occupies second bottoms, and is well drained. It is derived from the loessial uplands, comprising chiefly the Knox and Memphis silt loam. The soil has a good structure and is easily maintained in good condition. Wheat, corn, and oats do well. It is particularly adapted to early potatoes and to various truck crops.

Miller fine sandy loam.—The type is a grayish-brown to reddish fine sandy loam from 12 to 24 inches deep, underlain by a red heavy fine sandy loam or sandy clay. In local areas the soil may extend to a depth of 3 feet. This is an alluvial type, formed by the reworking of material wasted from the Permian Red Beds. The higher areas are seldom if ever overflowed. The type is well drained, except in small local areas. It is a good soil for corn and cotton and is also well adapted to truck and fruits.

Moshannon fine sandy loam.—The soil to a depth of 6 to 8 inches is a reddish-brown to Indian-red, light to heavy fine sandy loam. The subsoil is usually similar in color to the soil, but is more compact and often coarser in texture. Gravel beds are encountered within the soil profile. Rounded gravel is a common constituent of soil and subsoil. The type is of alluvial origin, having been derived from the Upshur soils. Fairly good crops of corn are grown. A number of vegetables do well.

Myatt fine sandy loam.—The soil is a gray, sticky fine sandy loam to a depth of about 10 inches. The subsoil is a drab or gray silty clay of tough consistency, mottled with iron stains and usually containing a large percentage of

iron concretions. The type occurs on stream terraces. Drainage is poor. Very little of this soil has been cultivated. The natural growth is gum, cypress, and oak, the latter producing valuable timber. The crop yields are only moderate, although with proper drainage and good treatment it is believed this soil could be brought into a good state of productiveness. Liming would prove beneficial.

Ocklocknee fine sandy loam.—This type consists of a light-brown or gray fine sandy loam about 10 inches deep, underlain by a light-gray or mottled brown, yellow, and gray fine sandy loam or loam. It is a rather variable alluvial soil, and occupies level or gently sloping bottoms. In some places the drainage is poor. Corn is a profitable crop and cotton does well on the better-drained areas.

Osage fine sandy loam.—The type is a dark-brown or grayish-brown fine sandy loam containing considerable organic matter and overlying a yellowish-brown or grayish subsoil. It occurs along small streams as first bottoms, and is derived from the deposition of stream sediments. It has fair natural drainage and is a desirable soil for corn and the staple crops.

Papakating fine sandy loam.—The soil is a dark-brown to black fine sand or fine sandy loam varying in depth from a few inches to a foot or more. The subsoil ranges from gray to yellowish gray in color and is generally sticky and compact. The type occupies first-bottom positions along streams, and its topography is nearly level. The land is subject to annual or periodic overflow. Drainage is poor in depressed areas. The forest growth consists of cedar, elm, and soft maple. When drained and cleared the type is well adapted to corn, oats, hay, potatoes, and vegetables.

Podunk fine sandy loam.—The soil to a depth of about 10 inches is a dark-brown fine to very fine sandy loam. The subsoil to 36 inches or more is a yellowish silty fine sand. More or less finely divided mica occurs in both soil and subsoil. The type occurs principally as flat or slightly undulating first bottoms along rivers and large streams. The drainage is usually good, and the soil is inclined to be droughty and leachy. It is of recent alluvial origin and is subject to overflow during flood stages of the streams. Originally the land was forested with oak, elm, maple, birch, and some pine. It is largely under cultivation, being well adapted to grasses and corn.

Sarpy fine sandy loam.—This is a rather silty fine sandy loam to a depth of about 12 inches, where it is underlain by fine sand. It occurs in the first bottoms of streams flowing through and issuing from the loessial region. The type is well suited to general farm crops.

Schuylkill fine sandy loam.—The surface soil consists of brown, dark-brown, or black fine sandy loam to light loam 10 inches deep. The black color is due in part to an accumulation of coal dust brought down the river from the anthracite region. The subsoil is a light-brown fine sandy loam to reddish-brown fine loam, with local color variations of yellow or gray. It is sometimes either micaceous or gravelly. The type occupies first bottoms along the Schuylkill River, and most of it is subject to overflow. Good yields of general farm crops are obtained. The soil is well adapted to trucking.

Teller fine sandy loam.—The soil is a fine sandy loam of gray or yellow color and is underlain by a red or yellow heavy fine sandy loam. The type occupies the highest river terraces and is above the limit of overflow. It is level to gently rolling in topography and has good natural drainage. It is of ancient alluvial origin. The principal crops grown are cotton and corn. Some attempt has been made to grow peaches on the type, and with favorable climatic conditions they should do well. Uncleared areas of the type are usually covered with a thick growth of oak.

Thompson fine sandy loam.—This is a grayish-brown fine sandy loam, underlain at about 6 to 15 inches by a yellow fine sandy clay, usually mottled with gray and shades of yellow and brown. The subsoil is sometimes slightly plastic, but is not so impervious as to prevent the establishment of good underdrainage by ditching. The type occurs in the first bottoms of streams and is subject to overflow. It is poorly drained, and in its natural condition is best suited to the production of native grass and lespedeza hay. By ditching much or most of it can be profitably utilized for corn, cowpeas, oats, cotton, and hay.

Toxaway fine sandy loam.—The soil to a depth of 8 to 10 inches consists of a light-brown to dark-brown, mellow fine sandy loam. In the poorly drained areas the soil is a light loam, and in the depressions spots of brown loam containing very little sand are found. The subsoil to a depth of 36 inches or more is a light-brown or yellowish-brown, loose fine sandy loam. In some places a

loamy fine sand is encountered, and in poorly drained areas, where silt and vegetable matter have accumulated, the subsoil is a yellowish-brown to brown loam or silt loam. In areas bordering large streams a large quantity of stream gravel is encountered at a depth of about 2 feet. Both the soil and subsoil are micaceous, and in some instances the proportion of mica present is sufficient to give the soil a smooth or greasy feel. The type occupies practically level areas along creeks and in oxbows of rivers. It is an alluvial soil, formed by the deposition of the coarser materials from the streams, modified in many places by colluvial wash from mountain slopes. Practically all of the type is under cultivation. The better-drained areas are adapted to corn and hay, and on the sandy phase melons and vegetables do well.

Trinity fine sandy loam.—The soil to a depth of about 10 inches is a dark-brown, usually heavy fine sandy loam. The subsoil is a brown to black heavy loam to clay. The type occurs in first bottoms generally near the footslopes where there has been more or less deposition of material from adjacent uplands. Except for occasional overflows, the type is fairly well drained. The material, particularly the subsoil portion, is derived from the calcareous prairies. Good crops of cotton, corn, forage, and sugar cane are secured.

Wabash fine sandy loam.—The soil consists of a brown to black fine sandy loam about 12 inches deep. The subsoil varies from a fine sandy loam to a fine sand, which is generally dark colored, though sometimes changing to yellow at about 24 inches. Frequently a larger amount of fine, rounded gravel is distributed throughout the subsoil. The type is alluvial and occupies flat bottom lands. Some areas produce heavy yields of wheat, oats, and corn, while the well-drained areas are better suited to melons, sugar beets, Irish potatoes, and alfalfa.

Waverly fine sandy loam.—The soil to a depth of 15 inches is a light-brown to gray fine sandy loam, the sand content being usually high and of the finer grades. The soil becomes heavier as the depth increases, and at from 15 to 20 inches grades into a brown fine sandy loam, with a larger percentage of silt and clay. The sand content, depth of soil, and size of the sand particles vary with location. The type generally occurs as slight ridges along streams. Its elevation above the streams assures good drainage. The soil is alluvial in origin. It is productive and easily cultivated, and in seasons of average rainfall the crop yields are large. The type is best adapted to corn, melons, early vegetables, and alfalfa. The other crops successfully grown are wheat, oats, potatoes, and tobacco.

Wheeling fine sandy loam.—This consists of about 10 inches of a loose, brown fine sandy loam, resting on a yellowish-brown fine sandy loam, which may become slightly heavier at 20 to 30 inches below the surface. Below 30 inches the texture again becomes more sandy. The material is alluvial, and the type occurs along stream courses on terraces of different levels. It is best adapted to melons and strawberries. Good crops of wheat, corn, potatoes, and hay are also produced. Small fruits, such as raspberries and blackberries, do well.

Yazoo fine sandy loam.—The soil to a depth of from 8 to 12 inches consists of a brown fine sandy loam. This is underlain at about 24 inches by a brownish-colored, compact fine sandy loam. Below 24 inches a bluish-colored clay loam is often encountered. The type occurs as long, low, narrow ridges or swells along streams and old stream channels. Its drainage is good, and it is only in times of most general inundation of the bottoms that the type is completely covered with water. It is of alluvial origin. Practically all of it is in cultivation to cotton and corn, though it is adapted to a variety of general farm crops, as well as to fruit and truck crops.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Cahaba fine sandy loam	Alabama 1, 2, 3, 12, 14, 17, 34, 37; Mississippi 3, 5, 9, 10, 12, 14, 20; South Carolina 8.	314,688
Ocklocknee fine sandy loam	Alabama 3, 8, 17, 27, 32, 37; Mississippi 9, 10, 14, 20	209,408
Miller fine sandy loam	Arkansas 3; Louisiana 3, 12, 14; Oklahoma 1; Texas 11, 24, 31	203,904
Frio fine sandy loam	Texas 28	165,888
Kalmia fine sandy loam	Alabama 1, 2, 3, 9, 12, 29, 32, 37; Mississippi 9, 10, 14, 20	158,336
Myatt fine sandy loam	Alabama 2, 5, 9; Florida 1, 7; Louisiana 12; Mississippi 10, 12, 15	86,656
Huntington fine sandy loam	Alabama 6, 11, 37; Arkansas 1; Pennsylvania 2, 8, 11; West Virginia 2, 4, 10.	62,080
Wabash fine sandy loam	Indiana 8, 10; Minnesota 1; Nebraska 6; Oklahoma 1	61,760
Bastrop fine sandy loam	Texas 2, 3, 33	61,440
Congaree fine sandy loam	Alabama 33; Georgia 13; North Carolina 10, 17; South Carolina 13; Virginia 4.	51,072
Holston fine sandy loam	Alabama 6, 11, 15; West Virginia 2	46,400
Sarpy fine sandy loam	Missouri 6, 10, 13, 15	36,096
Yazoo fine sandy loam	Louisiana 4, 6; Mississippi 6	33,088
Austin fine sandy loam	Texas 25, 33	32,576
Thompson fine sandy loam	Mississippi 20	32,448
Chastain fine sandy loam	Georgia 11, 16	28,928
Lintonia fine sandy loam	Indiana 2, 3; Kentucky 6	28,416
Podunk fine sandy loam	Connecticut 2; New Hampshire 1; 2; New York 4	28,224
Bibb fine sandy loam	Alabama 37; Mississippi 9, 14	26,752
Toxaway fine sandy loam	North Carolina 13, 27; Virginia 9	25,152
Genesee fine sandy loam	New York 2, 6, 10, 11; Wisconsin 8	24,832
Waverly fine sandy loam	Illinois 1; Indiana 2, 3, 8; Kentucky 6; Mississippi 4; Missouri 2, 21.	20,800
Teller fine sandy loam	Oklahoma 2	11,712
Osage fine sandy loam	Missouri 5	11,520
Wheeling fine sandy loam	Ohio 6; West Virginia 6, 7	6,912
Cumberland fine sandy loam	Alabama 35; Kentucky 3	5,696
Altavista fine sandy loam	North Carolina 15	3,968
Moshannon fine sandy loam	Pennsylvania 5	3,584
La Crosse fine sandy loam	Wisconsin 9	3,072
Elk fine sandy loam	Alabama 28	3,008
Schuylkill fine sandy loam	Pennsylvania 3	2,880
Papakating fine sandy loam	New York 5	2,176
Trinity fine sandy loam	Texas 1	1,600
Holly fine sandy loam	Alabama 20	1,472
Leaf fine sandy loam	Mississippi 5	1,472
Total		1,798,016

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

The soils of the very fine sandy loam texture occupy a comparatively small area in the River Flood Plains province, being confined, so far as the soil surveys have been extended, to the first bottoms, principally near the banks of streams.

These soils are adapted to the same crops as the fine sandy loams and require about the same kind of treatment. They are a little more productive than the corresponding members of the fine sandy loam group.

Genesee very fine sandy loam.—The soil is a brown or grayish-brown very fine sandy loam about 10 inches in depth. The subsoil is a light-brown or yellowish-brown very fine sandy loam, though there is some variation in texture and in some places in the lower subsoil lighter textured material is encountered. The topography is usually flat and the natural drainage deficient. The better drained areas have a high agricultural value for general farm crops or certain kinds of truck.

Miller very fine sandy loam.—The soil consists of a pinkish-red or chocolate-red, friable, very fine sandy loam, having a depth of 20 to 30 inches or more. The subsoil may consist of darker colored material or there may be very little change in the material throughout the 3-foot profile. Cotton, corn, and alfalfa should do well.

Olivier very fine sandy loam.—The soil to an average depth of about 10 inches is a grayish-brown, mellow, very fine sandy loam, usually with a high silt content. The subsoil is a mottled yellow and drab or rather dingy yellow silty clay loam. The type is characteristically developed on slight ridges standing but a few feet above the general level of the surrounding flat soils. Drainage is well established. Sugar cane, corn, cowpeas, sweet potatoes, Irish potatoes, and a number of vegetables can be successfully grown.

Osage very fine sandy loam.—The soil is a brown, grayish-brown, or brownish-gray very fine sandy loam about 12 inches deep, underlain by a heavier textured very fine sandy loam of brownish-gray or brownish-drab color. The type is level to gently undulating, and usually occurs at a higher elevation than the heavier members of the series, so that its drainage is better and it is earlier and better adapted to the production of corn, potatoes, and general truck crops.

Sarpy very fine sandy loam.—The soil of this type consists of a light brownish-gray or grayish-brown very fine sandy loam averaging about 12 inches deep. The subsoil is usually coarser in texture, grading into a very fine sand or fine sand, though in local spots this looser subsoil is separated from the surface soil by an intervening stratum of very fine sandy loam, slightly heavier than the soil itself. This intermediate layer is rarely over 6 or 8 inches in thickness, however, and is never thick enough to interfere with the subsurface drainage afforded by the loose, porous, deep subsoil. The type is nearly level to gently undulating or slightly ridged in topography, and occurs in the broad bottoms of the Mississippi, Missouri, and other large rivers of the Central Western States. It is a valuable soil for general farm crops and vegetables.

Wabash very fine sandy loam.—This is a dark-brown to black, friable, very fine sandy loam, rich in organic matter, overlying at a depth of about 18 or 20 inches lighter colored and somewhat heavier material. It mellows up readily, with little tendency to clod, and is a desirable soil, being well adapted to such vegetables as cabbage, onions, and potatoes. Corn and oats should give splendid yields, although the latter crop might give some trouble with lodging.

Yazoo very fine sandy loam.—The soil is a light-brown or grayish-brown, rather loose very fine sandy loam, ranging in depth from about 8 to 20 inches. The subsoil is a brown or light-brown very fine sandy loam, more or less mottled with rusty brown. The soil is typically and mainly developed along river fronts, where it occupies the well-drained natural levees. It is easily tilled and requires frequent replenishment of the organic matter content in order to supply crops with sufficient moisture during dry spells. A number of vegetables do well. Corn and cotton make fair yields.

Area and distribution of the very fine sandy loams.

Soil name.	State or area.[1]	Acres.
Yazoo very fine sandy loam	Louisiana 4; Mississippi 1	45,440
Sarpy very fine sandy loam	Kansas 5; Missouri 8, 16	17,024
Wabash very fine sandy loam	Louisiana 4; Missouri 13, 16	13,568
Osage very fine sandy loam	Kansas 9	4,096
Genesee very fine sandy loam	Pennsylvania 4	2,944
Olivier very fine sandy loam	Louisiana 10	1,536
Miller very fine sandy loam	Louisiana 4	1,472
Total		86,080

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loams of the River Flood Plains province comprise a large total area, being very extensive in the first bottoms.

They require more intensive cultivation than do the light-textured soils and somewhat heavier implements and stock to secure and maintain a good structural condition. The first-bottom types are also more difficult to protect from overflow and to keep in a proper condition of drainage, but on the other hand these soils are considerably more productive in both the first and second bottom developments. Fertilizers are generally not needed except occasionally in small applications on some of the poorer terrace types. Applications of lime, however, are beneficial, particularly in the case of those poorly drained types of both terraces and first bottoms which have not been influenced to any considerable extent by material washed from limestone or calcareous soils.

The loams are much better suited to the general farm crops than are the sandy loams, giving heavier yields of nearly all crops. Oats, corn, grass, wheat, sugar cane, and a number of forage crops give heavy yields. Cotton gives heavy yields in the South where the crop is not attacked by the boll weevil. Medium late truck crops, such as cucumbers, tomatoes, and cabbage, can be grown to

advantage, especially on those types of the terraces which have good natural drainage.

The Ocklocknee, Wabash, Yazoo, Congaree, Huntington, Genesee, Waverly, Bibb, Miller, and Trinity are the most extensive first-bottom members of the group, while the Cumberland and Cahaba are the most important terrace types.

Altavista loam.—The soil is a light-gray to dark-gray silty loam to fine sandy loam, averaging about 8 inches in depth. The subsoil is composed of pale-yellow silty loam to fine sandy loam and is underlain at about 12 inches by friable to plastic yellow silty clay to fine sandy clay. In slight depressions the soil is usually a dark-gray heavy silty loam, underlain by plastic yellow silty clay, sometimes showing red and drab mottlings. The type is of alluvial origin and occupies level to undulating stream terraces. It is well suited to the production of cotton, corn, oats, and grass.

Amite loam.—The soil consists of brown or light chocolate colored loam about 8 inches deep, underlain by a yellowish or reddish clay loam subsoil of uniform texture to a depth of 36 inches. The type is of alluvial origin and occupies the higher bottoms and terraces. It is a good corn soil, producing from 30 to 40 bushels per acre, and is also adapted to cotton, sugar cane, and some truck crops.

Aroostook loam.—The soil consists of a yellowish-brown or dark-brown heavy loam from 8 to 10 inches deep. The subsoil in the upper 10 inches is a mottled gray to brown silty loam to silt loam and below this a mottled, compact silt loam in which the gray color predominates. The type is inclined to be sticky when wet, on account of a relatively higher clay content, and is locally called "clay land." It occupies more or less distinctly developed terraces at the foot of slopes bordering streams. Oats and grass do well and potatoes fairly well.

Bibb loam.—The soil to a depth of 8 or 10 inches is a light-gray to white, rather compact loam or silty loam. The subsoil is a white or nearly white silt loam to silty clay loam, usually mottled with yellowish or brownish colors. The type occupies flat first bottoms and is subject to poor drainage conditions and overflow. The material is derived from Coastal Plain soils. The tendency to bake and to become compact frequently results in decidedly unfavorable structural conditions. Wild grasses flourish on this soil, affording excellent grazing. The type is well suited to hay crops. Corn and cotton give only moderate yields. Ditching is very much needed to insure better drainage. Applications of lime would also improve the condition of the soil.

Blanco loam.—The soil consists of a gray heavy loam to silt loam about 10 inches deep. When dry and baked a thin gray crust is formed on the surface, but when wet or recently cultivated the surface has a light-brown color. The soil grades into a light-brown heavy loam to silt loam subsoil, which gradually becomes heavier as depth increases and at from 30 to 36 inches changes to a heavy, plastic silty loam of a more decided brown color than the upper soil. The type occupies almost level areas along river courses. It is alluvial in origin and represents quite recent stream deposits. Its position along stream courses and its level topography make it possible to irrigate a very large part of this type. The soil is well adapted to general farm crops and to vegetables, but its limited acreage in any one locality causes it to be a soil of minor importance.

When irrigation is practiced cotton produces from three-fourths of a bale to a bale, and corn from 50 to 60 bushels per acre. Irish potatoes give excellent yields, and sweet potatoes also do fairly well. From 3 to 6 cuttings of alfalfa are obtained on irrigated areas, with an average yield of one-half ton per acre.

Buckner loam.—The soil is a dark-brown to nearly black loam about 12 to 15 inches deep. The subsoil is lighter brown in color and often lighter in texture than the soil. The type is developed on terraces or flat-topped ridges holding essentially the position of a second-bottom soil. It is well suited to cotton, corn, grain, and forage crops.

Cahaba loam.—The soil to a depth of from 4 to 10 inches consists of a grayish-brown light loam often approaching a fine sandy loam in texture. The subsoil is a brownish to reddish-brown clay loam to clay. The darker gray surface soil and the occasionally mottled subsoil are generally found in the lower lying and level areas. The type represents a second-bottom alluvial soil confined to the larger streams of the Gulf Coast States. The topography is undulating to level. The soil in the depressions is usually heavier than on the swells. Drainage varies according to topography, and the lower lying areas frequently require ditching. The original timber growth consists of hardwood and pine. With

good drainage the soil is suited to the production of crops like corn, cotton, and forage.

Congaree loam.—The soil is a brownish to reddish-brown fine sandy loam to medium heavy loam from 4 to 8 inches deep. The subsoil is a grayish-brown or reddish plastic clay, sometimes mottled with gray, and carrying considerable fine sand. In small local areas the soil is deeper and lighter in texture. This is an alluvial soil occupying flood plains of creeks and smaller streams, generally containing considerable organic matter. It is subject to frequent overflow. It is a good cotton, grass, and corn soil, and when properly drained is adapted to a wide variety of crops.

Cumberland loam.—The soil is a brown, rather mellow loam 6 to 15 inches deep. This is underlain by a brown to reddish-brown clay loam subsoil. Some rounded gravel occurs in both soil and subsoil. The type occupies second bottoms or high terraces along streams, occurring mainly in the horseshoe bends. The surface is generally rolling and drainage is good. This is a sedimentary soil, composed of materials washed from the uplands intermingled with materials brought from a greater distance by the river. It is well suited to general farm crops and is also used for truck crops, small fruits, and orchards.

Elk loam.—The soil of this type is a brownish-gray, medium-textured loam 6 to 8 inches deep. The subsoil is a yellowish-brown, heavy fine sandy loam or sandy clay, somewhat mottled below a depth of 2 or 3 feet. Quartz gravel is sometimes present in the subsoil. The type occurs as second terraces or filled-in and abandoned channels. It is not subject to overflow. It is alluvial in origin, the sediments being derived from limestone, sandstone, and shale soils. The soil is principally used for corn, wheat, oats, and grasses. Corn yields 25 to 40 bushels, wheat 10 to 20 bushels, and oats 30 to 50 bushels.

Franklin loam.—This type consists of a brown loam to heavy fine sandy loam with an average depth of 10 inches, underlain by a sandy loam whose color is lighter brown. The subsoil varies in texture and may be either lighter or heavier than the soil. The type is alluvial and has a nearly level topography. It is formed largely by wash from hills covered by Lamar soils. Though seldom subject to overflow, much of the type needs artificial drainage. Cultivation is not as extensive as it should be. Cotton and corn are the principal products.

Frio loam.—The Frio loam consists of 14 inches of grayish-brown loam containing a rather high percentage of silt and fine sand. The type has a grayish and sometimes yellowish appearance on the surface, but appears much darker immediately below. The subsoil is a light-brown to gray loam, much lighter in color and heavier in texture than the surface soil. Owing to its loamy character this is an easy soil to work under irrigation, but puddles easily if stirred when too wet. It has been mainly derived from a deposition of soil material from the Frio and Nueces Rivers, but has also been influenced to some extent by wash from nearby hills.

Genesee loam.—The soil consists mainly of a mellow, friable, brown to dark-brown medium loam to silty loam about 8 to 20 inches deep. The subsoil is a fine loam to clay loam ranging in color from light-brown to yellowish-brown. In places a substratum of coarse material is encountered below 3 feet. The type mainly occupies level first bottoms subject to overflow. Artificial drainage is generally necessary to insure best results in the lower-lying phase. Along some of the smaller streams of steeper gradient the type is not subject to overflow and is usually well drained. When protected from overflow and thoroughly drained this is a good soil for corn, wheat, grass, oats, onions, carrots, and cabbage. Corn yields from 40 to upward of 100 bushels per acre, oats about 40 bushels, hay 1 to 3 tons, onions from 500 to 800 bushels, and carrots as high as 1,000 bushels per acre. Potatoes and tomatoes do well. Celery, asparagus, beets, and sugar corn produce fair to good yields.

Holly loam.—The soil of the Holly loam varies, according to its position with reference to the streams along which it occurs, from a silty to rather sandy loam of gray to brownish color and from 8 to 12 inches in depth. The subsoil is also variable in color and texture, ranging from a mottled yellow and gray silty loam or silty clay to a brownish fine loam or clay loam containing small amounts of chert gravel. The natural drainage is generally poor, and overflows are frequent. The soil is apt to clod if plowed while too wet. The type is of alluvial origin, the sediments consisting of wash from limestone, sandstone, and shale uplands. The agricultural value of this soil is inferior to that of the greater part of the Huntington series. The type is best adapted to pasturage.

Holston loam.—The type consists of a yellowish-gray to light-brown silty loam or very fine sandy loam, 8 to 10 inches deep, underlain by a yellowish-brown

silty clay or very fine sandy clay, slightly mottled with redder colors in the lower depths. The subsoil is free from gravel, but in places waterworn gravel is scattered over the surface. The soil is generally deficient in humus and when dry its surface has an ashy-gray color. The type occurs as high stream terraces which have frequently been modified by erosion. A large part of the type is under cultivation, although it is not considered productive. Corn and wheat are the principal crops. Limited areas are devoted to oats, sorghum, cowpeas, hay, and pasturage.

Huntington loam.—The soil is a brown loam to silty loam, usually from 10 to 12 inches deep, and is underlain by light or dark-brown loam, silty loam, or clay loam. A sandy loam is sometimes encountered in the lower part of the subsoil. The type is level to slightly rolling and occurs mainly as stream-bottom land subject to overflow. It may also be found in small upland depressions. The soil is best adapted to the production of corn and hay, and much of it is used for pasture. It is adapted to truck crops where high water is not likely to cause injury.

Jackson loam.—The soil is a light-brown loam to an average depth of 14 inches, grading into a mottled sandy clay or clay subsoil. The type occurs as second bottoms, with a gently rolling surface, and is mainly alluvial in origin, though modified to some extent by alluvial wash. The soil produces about 15 bushels of wheat and from 25 to 40 bushels of corn per acre. Onions give large yields. The soil is well adapted to light farm crops and to truck, wrapper tobacco, and peaches.

Johnston loam.—This is a black mucky loam to heavy sandy loam, underlain at about 15 inches by gray heavy sandy clay mottled with yellow. The soil is typically developed in the first bottoms of streams in strips along the outer edge of the bottoms. There has been in places some addition of material from adjoining slopes through colluvial action, but the greater part of the component material is of alluvial origin. The elevation is a little above the associated swamp areas, and in places the soil approaches a second-bottom position, yet the Johnston loam is typically a first-bottom soil and is subject to overflow. It remains wet throughout a good part of the year, which accounts for the accumulation of a large supply of organic matter. Some areas of the soil can be cultivated in dry years. With drainage and diking most of it could be profitably used for corn, grass, and vegetables, such as cabbage and onions.

Kalmia loam.—The soil is a light-brown to pale-yellow loam. The subsoil is a yellow, compact loam, frequently mottled with grayish colors. The type occupies second bottoms, and has moderate to poor drainage. Its average yields are light. With drainage and liberal applications of manure yields can be materially increased.

Miller loam.—The soil is a brown, reddish-brown, or red heavy fine sandy loam to silty loam, varying in depth from 10 to 16 inches. The subsoil is a red or reddish-brown rather heavy loam to silty clay. The type occurs as stream-bottom land, and is largely composed of wash from Permian Red Beds. The principal crops grown on the type are corn, oats, wheat, and cotton. Corn will yield from 40 to 60 bushels, wheat from 20 to 35 bushels, and oats from 40 to 60 bushels per acre. Cotton will often yield more than a bale to the acre. Alfalfa should do well on all well-drained areas of this soil.

Moshannon loam.—The soil is a brownish-red to Indian-red loam 8 inches deep. The subsoil has the same color as the soil, but the sand content increases with depth. At 30 inches a layer of compact material is frequently encountered ranging from fine sandy loam to clay loam. Rounded gravel occurs throughout the soil and subsoil. The type is of alluvial origin, being derived from the Upshur soils. It produces heavy yields of corn, grass, and clover. Wheat and oats do well, but the straw is liable to be heavy enough to cause lodging. The better-drained areas make good crops of potatoes.

Ocklocknee loam.—The soil is a brown heavy sandy loam to heavy loam 8 to 24 inches in depth, with a subsoil of a grayish clay loam or sandy clay, mottled with brown, yellow, and red. Both soil and subsoil are somewhat variable. The type occupies bottom lands and is for the most part alluvial, though some small areas are probably colluvial in formation. It consists principally of material derived from Coastal Plain soils. In some localities it is subject to overflow. The timber growth consists of white and water oak, gum, hickory, magnolia, and shortleaf pine. There is often a dense undergrowth of vines, briars, and shrubbery. Some of the soil is cultivated to cotton, corn, oats, Johnson grass, sorghum, sugar cane, and alfalfa, producing good yields where drainage is sufficient.

Sanders loam.—The soil is a dark-brown, reddish-brown, or gray loam. The subsoil is lighter in color and generally heavier in texture. The type occurs in the overflowed bottoms of streams in eastern Texas and northwestern Louisiana. It is considered a good corn soil, producing as much as 45 bushels per acre where well drained. It is not considered so good for cotton, producing about one-half bale per acre. Bermuda and Johnson grass flourish. The soil generally is in need of drainage.

Sarpy loam.—The soil of the Sarpy loam is a dark-gray to almost black, rather fine-textured loam with an average depth of about 10 inches. An exposed surface of the soil when dry has a light-gray color, but upon wetting it becomes almost black. The soil is immediately underlain by a yellowish-gray subsoil, which is generally a very fine sandy loam containing large amounts of coarse silt. In some areas, however, the subsoil is a light fine sandy loam or silt loam. The contrast between the soil and subsoil is fairly distinct. The type occupies the low ridges and higher elevations of first bottoms, rising probably 5 or 10 feet above the neighboring lowlands. Because of its texture and structure, which allow rapid seepage of rain water, and its elevation, which is usually above normal overflow, it has good drainage. All general farm crops, including corn, wheat, oats, clover, and alfalfa, do well, and large yields are secured. This soil is also well adapted to a large number of truck crops.

Toxaway loam.—The soil to a depth of 8 to 15 inches consists of a black, dark-brown or dark-gray silty loam or loam. Typical areas contain large amounts of organic matter. Spots of dark-gray or brown silty loam to very fine sandy loam are of frequent occurrence. The subsoil is a brown or yellowish-brown silty loam or loam. In places the silty material grades into a yellowish or white silty clay at 20 to 24 inches, and occasionally at 30 inches a highly micaceous fine sandy loam or fine sand is encountered. The type is an alluvial soil occupying river bottoms. In some places it has a gradual slope toward the upland, while in others it is flat. A large part of it is subject to overflow. Practically all of the type is under cultivation or included in pasture. It is considered a very productive soil and is especially adapted to corn, grass, and rye. On some areas celery, cabbage, cucumbers, and pumpkins would do well.

Trinity loam.—The soil to a depth of about 12 inches is a dark-brown to black loam or silty loam. The subsoil is a heavy loam to clay loam of somewhat stiff and plastic structure and usually dark brown to nearly black in color. The type occurs in the first bottoms of streams as flat areas interrupted only by occasional stream channels. The material is derived largely from the calcareous prairies and contains enough organic matter and lime to constitute a soil of good structure. Some of the type is subject to overflow and poor drainage conditions. In good seasons cotton, corn, and sugar cane do particularly well. The better-drained areas are well suited to alfalfa.

Wabash loam.—Owing to its wide distribution and its alluvial origin from the wash of soils of different texture, this type shows a wide local variation. It is generally a brown loam about 10 inches deep, often containing small quantities of sand and in local areas some gravel. The subsoil is usually a heavy, brownish-yellow loam 20 to 40 inches deep, overlying a gravelly loam. The type occurs as first bottoms along rivers and small streams heading in or passing through areas of loessial upland soil, and much of it is subject to periodical overflow. It is a first-class corn soil, producing from 35 to 60 bushels per acre. This type could be used more extensively for the production of canning crops, such as sugar corn, green peas, tomatoes, etc.

Waverly loam.—The type consists of a gray to grayish-brown loam about 10 inches deep, underlain by a brown to yellowish clay loam or clay. It occurs as first-bottom lands along rivers and creeks. The surface as a rule is flat, though occasionally it is slightly rolling. Open ditches are frequently necessary to provide adequate drainage. The type is alluvial in origin. The original timber growth consists mainly of gum, sycamore, water oak, beech, and willow. The soil is adapted to corn, wheat, and grass, as well as to forage crops, and large yields are secured when no injury is sustained by overflows.

Wehadkee loam.—This type is a gray, compact silty loam, underlain at about 8 to 12 inches by compact, grayish-yellow to nearly white, or mottled yellowish and gray clay. The type is developed in the bottoms of streams and consists of alluvial material derived from Piedmont soils. It is subject to overflow, and is best suited to grasses and lespedeza.

Wickham loam.—The soil to a depth of about 10 inches is a yellowish-brown or chocolate-colored loam, resting on a loam of lighter color and slightly heavier

texture, which becomes heavier with increasing depth and grades into a clay loam at about 30 inches. Both soil and subsoil contain fine particles of mica. The type occupies terraces along stream courses, and is comparatively level in topography, with an occasional slight elevation or very slight depression. It is largely composed of material washed down from the Piedmont region and deposited during periods of overflow when the waters reached higher levels than at present. The soil is a desirable one for cultivation. Corn yields from 40 to 60 bushels, wheat from 15 to 25 bushels, oats from 30 to 40 bushels, and timothy from 1 to 2 tons per acre.

Yazoo loam.—The soil is a light-brown loam about 6 inches deep. The subsoil is usually a silt loam, but in local areas may be a silty clay or fine sandy loam. The type occupies low ridges in river bottoms, and represents the higher-lying areas of fine sediment deposited by inundations. It is a strong cotton soil, producing a bale per acre. In northern areas the soil is adapted to corn and wheat.

Areas and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Ocklocknee loam	Alabama 18, 22, 30, 32, 34; Mississippi 3, 8, 12, 15, 17	317,248
Wabash loam	Illinois 10; Indiana 3, 5; Michigan 7; Minnesota 4; Missouri 10, 17; North Dakota 2, 8, 9; Ohio 3, 4, 5, 7, 8, 9; Wisconsin 5, 9, 11, 12, 14.	257,840
Yazoo loam	Illinois 1, 7, 9; Kansas 1, 4; Louisiana 6, 7, 11; Mississippi 6, 19, 21; Missouri 4, 14, 18.	204,803
Congaree loam	Alabama 7, 33; Mississippi 16; North Carolina 5, 23; South Carolina 16; Virginia 5.	155,520
Genesee loam	New Jersey 2; New York 1, 3, 6, 8, 9, 10, 12, 13, 14, 15; Ohio 2; Pennsylvania 7; Wisconsin 1, 8.	128,768
Huntington loam	Alabama 1, 10; Arkansas 2; Kentucky 4; Missouri 4; Pennsylvania 2, 8, 11; Tennessee 4; Virginia 9; West Virginia 2, 4, 7, 10.	124,160
Frio loam	Texas 28	73,728
Waverly loam	Indiana 8; Tennessee 6, 8	72,768
Cahaba loam	Alabama 2, 14, 17, 37; Mississippi 12	70,976
Kalmia loam	Alabama 22; Mississippi 5, 17	64,064
Cumberland loam	Kentucky 2; Tennessee 2, 4, 5; Virginia 9	61,184
Bibb loam	Alabama 22; Mississippi 15	50,304
Sarpy loam	Missouri 1, 15, 16	47,104
Miller loam	Oklahoma 1, 2	37,184
Trinity loam	Texas 14	25,280
Jackson loam	Missouri 13, 20	22,464
Elk loam	Alabama 26; Tennessee 1	22,016
Sanders loam	Texas 23, 24	17,408
Amite loam	Louisiana 13	16,320
Moshannon loam	Pennsylvania 2, 5	13,504
Toxaway loam	North Carolina 13, 27	11,328
Holston loam	Alabama 16; Tennessee 4	7,168
Johnston loam	North Carolina 15	6,528
Altavista loam	North Carolina 23	6,080
Holly loam	Tenessee 1	5,952
Wickham loam	Virginia 5	5,952
Blanco loam	Texas 26	5,376
Franklin loam	Texas 7	1,280
Wehadkee loam	Alabama 33	704
Buckner loam	Missouri 10	320
Aroostook loam	Maine 1	64
Total		1,833,395

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam alluvial soils are confined chiefly to the eroded second bottoms. There are, however, some small areas in the first bottoms, especially along small streams. These soils have very nearly the same crop adaptation as the loams, but those especially on the terraces where the surface has been more or less eroded give lower yields on account of the hindrance offered to cultivation by topography.

Barbour gravelly loam.—The soil is an Indian-red, brownish-red, or grayish-red loam, containing considerable water-worn gravel, with a small amount of stone, consisting generally of red shale and sandstone. The subsoil is an Indian-red loam, its color being darker and more intense than that of the surface soil. The quantities of gravel in the subsoil are often so great as to

interfere with boring. The topography ranges from level to undulating, rolling, or sometimes sloping, and surface drainage is better than that of the finer textured members of the series. The soil is alluvial in origin, the sediments having been derived from wash from red glacial upland soils, such as the Lackawanna. The soil is subject to overflow, though the presence of gravel renders the subsoil porous to such an extent that water readily percolates through it and early spring cultivation is possible. In dry seasons the crops suffer for moisture.

Cumberland gravelly loam.—The soil from 6 to 12 inches deep is a grayish to brownish-gray loam. Its texture often approaches a sandy loam. The subsoil is a heavy, reddish-brown loam to clay loam, which generally grades into a heavier material with an increasing amount of red coloring. At from 30 to 36 inches it frequently becomes a yellowish-red to red clay. Rounded pebbles and cobblestones occur on the surface and through the soil. The type occupies the crests and slopes of the hills and ridges along stream courses. It produces good yields of corn, wheat, oats, and grasses.

Huntington gravelly loam.—The soil consists of about 10 inches of brown loam or silty loam, containing a great amount of gravel. This is underlain to about 3 feet by a similar textured, lighter colored material which contains larger quantities of gravel. The type is variable in color, texture, and gravel content. In the lower depths a bed of gravel and broken rocks is encountered, frequently cemented together. The soil occurs as bottoms along the smaller streams, and usually there is a gentle slope from the stream to the steep hills. The type consists of material washed from adjoining slopes combined with alluvial deposits. It is well drained. All of it is in cultivation and produces fair yields of corn, wheat, and cotton.

Travis gravelly loam.—The soil is a coarse sandy loam, containing a large quantity of rounded gravel both on the surface and in the soil. This grades at a depth of 10 to 12 inches into a mass of coarse sand and rounded gravel cemented together by a stiff, sticky red clay. The soil is derived from material brought down by river waters at an earlier period and deposited along their courses, and forms a series of terraces on each side of the streams. Many of the rounded pebbles are of quartz and granite. The location of the soil, together with its open structure, allows water to seep rapidly through it, so that crops suffer severely from drought. On a few of the more level areas cotton, corn, and oats are grown, but the yields are small. The type seems best adapted to melons and tree fruits, but large areas are rendered valuable mainly by a heavy growth of post oak and blackjack oak.

Wheeling gravelly loam.—To a depth of from 8 to 10 inches the soil is a brown gravelly loam. The fine earth varies from silt loam to sandy loam. The subsoil to a depth of 3 feet or more is a light-brown or yellowish gravelly loam, the fine earth of which varies from silt loam to sandy loam. From 30 to 60 per cent of water-worn gravel composed of granite, quartz, quartzite, sandstone, and shale is found in both soil and subsoil. The topography of the type varies from level to rolling and hilly. The soil consists of reworked material brought from glacial regions by stream waters when they were of much greater volume than at present. The soil is adapted to watermelons and tomatoes. Of the general farm crops it seems best suited to corn. Wheat does fairly well.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Huntington gravelly loam	Alabama 21; Missouri 11; Pennsylvania 5; Tennessee 3, 12	43,328
Wheeling gravelly loam	Ohio 6; Pennsylvania 9, 10; West Virginia 4, 6, 7, 10	29,830
Travis gravelly loam	Texas 2, 31	25,728
Cumberland gravelly loam	Alabama 26; Virginia 9	4,800
Barbour gravelly loam	Pennsylvania 4	3,648
Total		107,334

[1] For key to numbers in this column see p. 733.

SHALE LOAM PHASE.

The shale loam phase is represented by a single type, the Genesee shale loam. This soil has about the same crop adaptation as the Genesee loam, but the yields are not quite as good, owing to the difficulty offered to cultivation by the large amount of shale fragments present and to the droughty nature of the soil.

Genesee shale loam.—The soil is a heavy silt loam, brown to dark brown in color, having a depth of 6 or 8 inches. The subsoil is of the same character, but slightly lighter in color. Both soil and subsoil contain from 25 to 50 per cent of small, thin shale fragments. It is particularly adapted to the production of hay, oats, and corn.

Area and distribution of the shale loam.

Soil name.	State or area.[1]	Acres.
Genesee shale loam	New York 6, 13	2,944

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

Of the Flood Plains soils which have been differentiated into series and types the silt loam is next to the most extensive group. The most widely developed types are confined to the first bottoms of streams rising in and flowing through regions occupied by loessial soils and by soils of the Appalachian Mountains and Limestone provinces.

The better-drained silt loams are easily kept in favorable structural condition, but those which are subject to intermittent wet and dry periods between overflows are inclined to become compact and the maintenance of good tilth requires frequent cultivation with substantial tools and strong stock. Most of those types not influenced by sediments derived from calcareous soils are improved by applications of lime. Only a small part of the total area occupied by the silt loams is in need of commercial fertilizers. The biggest problem in connection with the agricultural utilization of these soils is the protection from overflow and the establishment of proper drainage.

The silt loams are particularly adapted to the production of general farm crops, including corn, wheat, grass, forage crops, sugar cane, and rice. Wheat frequently lodges in the most productive first-bottom types, but where this can be prevented the yields are usually heavy. Early maturing types of cotton do well in the southern areas where the boll weevil has not become a formidable enemy. Certain late-maturing truck crops, as cabbage, Irish potatoes, and tomatoes for canning purposes, can be successfully grown on the better-drained types.

Along streams flowing through and rising in the loessial regions the Wabash and Waverly silt loams are the most extensive types in the first bottoms, while the Lintonia is the important terrace member of the group. The Huntington silt loam is the most important type in the first bottoms of streams receiving their principal wash from Limestone and Appalachian soils. The other members of the group are less extensive and are widely scattered. They comprise, however, a large total area of very valuable farming land.

Abernathy silt loam.—The soil of this type is a reddish silt loam about 8 inches deep, underlain by a mottled gray and brown subsoil of somewhat heavier texture. The type occurs in depressions which resemble sink-holes, where in many instances ponds or lakes have formerly stood, and in the first bottoms of streams. The soil for the most part consists of alluvial or colluvio-alluvial material derived mainly from soils of the Decatur series. When well drained fair yields of corn, grain, grass, and forage crops are secured.

Altavista silt loam.—This type consists of a gray to yellow, compact silt loam to silty clay loam underlain by a compact, yellow silty clay mottled slightly with red or gray. The type is alluvial in origin and occupies well-defined stream terraces lying above normal overflow. Surface drainage, such as can be secured by ditching, is needed over most of the type, as the flat topography favors the standing of rain water. When properly drained, fertilized, and cultivated good yields of grass, corn, wheat, and oats are secured.

Aroostook silt loam.—The soil to a depth of about 10 inches is a dark-brown, friable, mellow silt loam. The subsoil is a lighter brown silt loam, slightly mottled with gray and chocolate brown. The type usually becomes sandier with increase in depth, passing into a stratum of dark-colored gravel at from 3 to 5 feet. The soil is alluvial in origin and occupies first bottoms. It is subject to overflow, but this usually occurs in the spring, so that crops are seldom injured. The soil is very productive, giving large yields of potatoes of excellent quality. Potatoes yield as high as 100 barrels and over, oats from 40 to 50 bushels, and hay from 1 to 2 tons per acre.

Auglaize silt loam.—This is a black, friable silt loam, underlain at an average depth of about 13 inches by a heavy silt loam which grades quickly into a slightly plastic silty clay loam to silty clay. The subsoil is black, but not so decidedly black as the surface soil. In places the texture approaches a silty clay, while elsewhere there is little change from a silt loam within the 3-foot section. This is a stream-bottom type, the material having been washed from black residual limestone soil. It is subject to overflow and some areas remain in a permanently wet condition on account of springs. The soil is productive, giving good yields of corn, oats, timothy, and clover.

Barbour silt loam.—The soil is an Indian-red silt loam about 8 inches deep, overlying a somewhat lighter red, more compact silt loam or silty clay loam. Little stone or gravel occurs in the soil profile, though gravel may in some localities underlie the type at a depth of 3 feet or more. The topography is flat, the type being developed on first bottoms. It is subject to overflow. The drainage varies from fair to poor. Under the best drainage conditions the soil produces good yields of corn, oats, wheat, and buckwheat.

Bastrop silt loam.—The soil is a heavy, brown silt loam generally 12 inches deep, while the subsoil to a depth of 36 inches is a brown silt loam to silty clay, quite compact and somewhat darker in color than the surface soil. Small shell fragments are disseminated through the soil and subsoil and occasion the local name of "shell lands." The soil has a tendency to bake, and its cultivation is difficult. The type is alluvial and occupies second bottoms of streams where the topography is rather flat. It stands above overflow and as a rule the drainage is very good. It is largely devoted to cotton and corn, though some oats, hay, and alfalfa are grown. Melons and potatoes give excellent yields and pecans are indigenous. While the soil is naturally productive and gives good returns, much larger yields could be secured with improved methods.

Bibb silt loam.—The soil is a white silt loam which when dry has a floury feel. The subsoil is reached at a depth of about 10 to 15 inches and consists of a white, compact silty clay, slightly mottled with streaks of yellow and brown. Iron concretions are frequently encountered in the subsoil. The type occupies first bottoms and is poorly drained. The material is derived through wash from the Coastal Plains soils. Its agricultural value is low, although lespedeza and a number of native grasses afford good grazing and hay.

Birdsboro silt loam.—The soil is a yellowish-brown silty loam about 10 inches deep, with local variations caused by more than a normal content of fine sand. The subsoil is a yellow or yellowish-brown silty clay loam. A few rounded stones and some small gravel occur on the surface and through the soil and subsoil. The type occupies second terraces of streams rising in the Appalachian and Limestone provinces and flowing through the northern part of the Piedmont Plateau. It is not subject to overflow, and constitutes a fairly good general farming soil. It is also used to some extent for trucking, to which it seems to be adapted.

Biscoe silt loam.—The type consists of 8 to 12 inches of a loose, chocolate-colored silt loam, underlain to a depth of 36 inches by a yellow or brownish-yellow silt loam. The subsoil is quite light to a depth of 24 inches, while from 24 to 36 inches it often consists of a heavy silt loam, sometimes slightly mottled with gray. The surface in many places is rather sandy, the sand being from fine to medium in texture. The type occupies gently rolling areas and is fairly well drained. It is of ancient alluvial origin and may be considered as second-bottom land. The entire type is never overflowed, but during periods of high water parts of it are inundated. It is well adapted to cotton, and cotton and corn are the leading crops. With proper cultural methods it should prove an excellent truck soil. It is also adapted to the growing of alfalfa.

Buxin silt loam.—The type includes a shallow, reddish silt loam of Miller material overlying stiff, plastic, mottled drab, bluish, and brown clay of Sharkey material. With reclamation it should prove a good corn, cotton, and probably alfalfa soil.

Cahaba silt loam.—The type consists of a yellowish-gray or light-brown loam from 8 to 10 inches in depth, underlain by a reddish-brown silt loam or loam. Gray mottling often appears in the deeper subsoil. The type is alluvial in origin and usually occurs as broad, high terraces along the larger streams in the Coastal Plain of the Gulf States. It lies either entirely above overflow or above all ordinary freshets. The topography is level to gently undulating and except in depressions drainage is fairly good. The soil is easily handled and produces good general farm crops. With improved methods of cultivation and proper crop rotation a bale or more of cotton or upward of 40 bushels of corn have been produced on an acre.

Catalpa silt loam.—The soil to a depth of 8 to 20 inches is a dark-brownish, brownish-gray, or light-gray heavy silt loam to silty clay loam. The subsoil varies from a jet-black tough clay in the smaller bottoms to a dark-grayish mottled clay in the larger bottoms. It is largely alluvium, the grayish surface material representing comparatively fresh deposits washed from nearby exposures of Selma chalk or areas of Houston chalk. The soil is valuable for general farming.

Chariton silt loam.—The surface soil of the Chariton silt loam is a dark-gray or dark-brown to black mellow silt loam to a depth of about 12 inches. From 12 to 18 inches the soil is a gray silt loam to silty clay, with a few round concretionary iron nodules. Below 18 inches the subsoil is a brown, grayish-brown, or dark-gray, heavy and tenacious clay, mottled with brown to reddish brown and gray. The deeper subsoil is often lighter than the upper subsoil, being a mottled brown and gray silty clay. Practically all of the type is in cultivation to corn, timothy, oats, wheat, and clover.

Collins silt loam.—The soil consists of about 24 inches of a brown silt loam, underlain to a depth of 36 inches by a gray silt loam. The type occupies narrow bottom-land areas along small streams and is very nearly level in topography. It is profitably cultivated, although occasional crops are lost on account of overflow. The type is alluvial in origin. The principal crops grown are cotton, corn, and potatoes. The forest growth on uncultivated areas is white oak, pin oak, and elm.

Congaree silt loam.—The soil is a brown to reddish-brown or chocolate-brown silt loam, with but slight change in color and texture to a depth of about 24 inches. The subsoil is usually a friable silt loam of somewhat lighter color, more or less mottled with shades of brown. Strata or pockets of sandy material are frequently encountered in the soil. The type comprises first-bottom alluvial soil subject to overflow. It is admirably adapted to corn, oats, forage crops, and grass. Cotton also does well under favorable seasonal conditions.

Cumberland silt loam.—This soil is a light-brown silt loam 6 to 12 inches deep, frequently containing a large quantity of fine sand and some waterworn gravel. The subsoil consists of a reddish-brown to red silt loam or silty clay loam. The type is composed of sediments deposited along streams when the water reached higher levels than at present. A part of the material was probably washed down from the near-by hills. As the streams deepened their channels the terraces were subjected to erosion. The type is marked by low, rolling hills and gently sloping forelands extending back from the streams to the higher elevations occupied by the uplands. Its high position, often 50 to 100 feet above the stream, insures ample surface drainage. The soil retains sufficient moisture for successful plant growth, and crops rarely suffer from drought. It is a rich, productive soil and is easily cultivated.

Elk silt loam.—The soil is a grayish to light-brown silt loam 6 to 12 inches deep. The subsoil is a compact silt loam, of lighter color than the surface soil, sometimes faintly mottled with yellowish and grayish colors, especially in the lower sections, where a silty clay predominates. At about 4 feet gravelly material is frequently encountered. The type occurs on second terraces lying largely above overflow. The surface is sometimes so flat as to cause poor drainage conditions, and a great part of the type should be ditched or tiled. Under the usual methods of cultivation corn yields from 15 to 30 bushels, wheat 10 to 15 bushels, oats 15 to 25 bushels, and hay 1 to 1½ tons per acre.

Genesee silt loam.—The soil consists of a brown to dark-brown silt loam from 10 to about 12 inches deep. The subsoil is a brown silty loam to silt loam, sometimes resting on lighter material in the lower sections or substratum. The type occupies level stream bottoms and is largely subject to overflow. Artificial drainage is necessary with the greater part of the type to insure good results with crops. The soil is very productive. When thoroughly protected from overflow and properly drained it produces from 30 to 75 bushels

of corn and from 75 to 150 bushels of potatoes per acre. Sugar beets do well, yielding as high as 18 tons per acre. Oats succeed quite well and wheat fairly well. Peppermint, beans, and late vegetables, such as cabbage, are successfully grown.

Hamlin silt loam.—The soil is a chocolate to reddish-brown silt loam 8 to 14 inches deep, underlain to a depth of 36 inches by a somewhat heavier and darker reddish-brown subsoil. The topography is flat and the type is subject to some overflow from the small streams along which it occurs. In spots some surface incrustation occurs, the chemical analyses of which show the presence of sodium chloride. These patches are too small to indicate on the map, but occur throughout the type. The soil is adapted to pasturage, but owing to its position near the streams and its liability to overflow it is not used to any considerable extent for the production of intertilled crops.

Holly silt loam.—The soil is a gray to light-brown silt loam about 6 to 8 inches deep. The subsoil is a compact gray silt loam mottled with yellow and brown. The lower part is more intensely mottled, bluish and drab colors frequently coming into prominence. The type is rather clammy and cold natured, remaining in a soggy condition throughout a good part of the year. It occurs in the first bottoms of streams and is subject to frequent overflow. Grass, especially redtop and a number of wild water-loving varieties, afford good grazing and make fair yields of hay. Corn and oats also do well in seasons of normal rainfall, especially where the drainage has been improved by ditching or tiling.

Holston silt loam.—The soil to a depth of 10 inches is a gray to yellowish-gray or grayish-brown silt loam. The subsoil to 36 inches is a yellow to yellowish-brown clay loam passing into a clay of the same color. A few rounded gravel and cobblestones occur on the surface of some of the more eroded areas. The type occupies stream terraces which frequently stand several hundred feet above the level of the streams. It is also developed in some abandoned stream valleys, such as Teays Valley in West Virginia. Land of this kind gives fair to good yields of the general farm crops.

Huntington silt loam.—The soil to a depth of about 12 inches is a yellowish-brown to brown silty loam to silty clay loam, sometimes containing from 15 to 20 per cent of sand of the finer grades. The subsoil is either a somewhat lighter brown clay loam in which the sand content becomes slightly greater as depth increases, or its texture may differ but little from that of the soil. The lower section of the subsoil often consists of very fine sand or fine sandy loam grading into coarser water-bearing material. The type occupies bottom lands and owes its origin to recently deposited sediments. It is level to slightly rolling in topography and is subject to overflow. The principal crops grown on the type are corn, potatoes, and hay. Wheat is sometimes produced on the higher areas, where there is less danger from overflow.

Iberia silt loam.—To its usual depth of about 6 to 12 inches the soil is a dark ashy-gray to black mellow silt loam, showing a slight mottling of yellowish-gray in the lower part. The subsoil is generally developed in two distinct strata. The upper section is a dingy-brownish silt loam, slightly mottled with bright yellow, while the lower, beginning at 18 to 22 inches, is typically a yellow silt loam. Lime concretions are common in the subsurface soil and subsoil, the quantity sometimes being so great as to interfere with plowing. In places the upper subsoil is of a decided gray color and very calcareous. Drainage is rather poorly established, and ditching is necessary in order to bring the land into proper condition for best crop results. Sugar cane, corn, and cowpeas do well, and some vegetables are successfully grown. Most of the type was originally prairie.

Kalmia silt loam.—The soil consists of a yellowish-brown to pale-yellow, rather compact silt loam. The subsoil is a yellow, compact silt loam, frequently mottled with grayish colors. The type occupies second bottoms and drainage is moderately good to poor. Crop yields are light. The soil is difficult to maintain in a good condition of tilth unless supplied with organic manures.

La Crosse silt loam.—To a depth of about 12 inches this is a black or brownish-black silt loam of smooth feel. The subsoil is a chocolate-brown silt loam to about 16 to 20 inches. Beneath this depth it becomes yellowish brown in color and changes to a silty clay in texture. Below 2 to 3 feet the subsoil becomes lighter in texture and contains sand and small rounded gravel. The topography varies from level to undulating or somewhat hilly.

The soil is less typical on the tops of the low hills and knolls where more or less erosion has taken place, and its color is lighter. While for the most part

this type is of old alluvial origin, the silty surface in some areas may be due to colluvial wash from the silt loam uplands. The soil is easily cultivated. Where the topography is flat and the sand or gravel is not encountered at less than 3 feet the drainage is apt to be inadequate, but on the whole drainage is well established. The soil is adapted to small-grain and hay crops.

Laredo silt loam.—The soil to a depth of about 12 inches consists of a gray to light-brown silt loam, which usually contains a considerable amount of fine and very fine sand in the upper 6 to 10 inches. The subsoil to a depth of 36 inches is composed of similar material, but usually contains less fine sand and is slightly lighter in color. The general topography is almost level. The soil is composed of alluvial stream deposits laid down at times of early floods. A comparatively large part of the type is under cultivation and the greater part of the cultivated area is under irrigation. When irrigated the soil produces very profitable yields of all crops grown, but on the unirrigated areas the yields are usually light and the crops are often total failures. The principal crops are onions, cotton, sweet potatoes, and cowpeas. Beets, turnips, and strawberries are successfully grown.

Lintonia silt loam.—The soil consists of a brown silt loam about 10 inches deep. The subsoil is a yellow silt loam, quite uniform in color and texture, sometimes underlain by silty clay loam at a depth of from 3 to 4 feet. The soil lacks plasticity, and has rather a mealy character. The type occupies stream terraces. A colluvial phase is found along the foot of bluffs and as narrow strips in stream valleys, adjoining higher-lying areas of Memphis silt loam or Knox silt loam. The soil represents reworked material of the Memphis and Knox silt loams. It is rarely inundated, but is in places subject to the addition of colluvial material from uplands during winter rains. This is a good cotton soil and is also adapted to market gardening and fruit culture. In the northern areas it produces corn, wheat, hay, oats, and potatoes.

Miller silt loam.—The surface soil consists of a brown, red, or light-chocolate colored silt loam, varying in depth from 6 to 20 inches. The subsoil is a red heavy silt loam, often grading into a lighter-colored fine sandy loam at about 2 or 3 feet. The type is alluvial and occupies level or slightly rolling areas, subject to overflow. The soil is friable, productive, and easily cultivated. In general it is naturally well drained. The type is adapted to cotton, corn, alfalfa, and sugar cane, and also to late vegetable and truck crops. The timber growth includes cottonwood, ash, hickory, red oak, and sweet gum.

Moshannon silt loam.—The soil to an average depth of 10 inches consists of a reddish-brown to Indian-red silt loam. The subsoil is very similar to the soil in texture, but differs from it mainly in the closer structure and brighter red or Indian-red color. The type occupies first bottoms and is derived largely through wash from the Upshur soils. It averages somewhat more productive than the Huntington silt loam, possibly on account of a higher lime content resulting from the presence of a larger amount of material washed from the more calcareous shales which give rise to the Upshur soils.

The type is inclined to clod, but as a rule it is easily kept in a good tillage condition. The general farm crops and grass do well.

Myatt silt loam.—This is a light-gray silt loam, underlain at about 6 or 8 inches by mottled gray and yellow silty clay loam or silty clay. The type is developed in flat to slightly depressed, poorly drained situations on stream terraces. It is best suited to grass and lespedeza. The drainage can be improved by ditching so that fair crops of corn, sugar cane, and oats can be made. Applications of phosphoric acid and lime are advisable.

Neosho silt loam.—The soil to a depth of 8 inches is a light-colored, somewhat ashy silty loam containing small amounts of fine and very fine sand. The subsoil from 8 to 25 inches is a drab, compact, and impervious silty clay, locally known as "hardpan." The type occurs principally upon terraces from 5 to 15 feet above the level of the stream bottoms. Its elevation is sufficient to insure it against overflows and to afford fair surface drainage. Deep plowing or subsoiling and the addition of organic matter would greatly improve its moisture-holding capacity. The soil is largely an old alluvial deposit, greatly influenced by wash from the adjoining uplands. It is probably best adapted to wheat and grass, but corn and oats do well when the season is not extremely wet or dry.

Ocklocknee silt loam.—The soil consists of a dark-grayish to brown silt loam having a depth of about 9 inches. The subsoil is a brownish or grayish silt loam to silty clay loam, and grades into a rather heavy mottled gray and brown clay. On the higher swells the material is lighter in texture, sometimes

approaching a fine sandy loam, while in depressions the heavier phase is encountered. The subsoil is more mottled in the level and depressed areas. The type is of alluvial origin and is confined to the first bottoms of streams of the Coastal Plain. It is subject to overflow and much of it is rather poorly drained. Where well drained and properly handled it produces good crops of corn and cotton.

Olivier silt loam.—The soil to a depth of about 10 to 15 inches is a brown, mellow silt loam, occasionally somewhat grayish in the dry immediate surface portion. The subsoil is predominantly a mottled yellow and drab silt loam to silty clay loam. In many places the subsoil is yellowish brown, faintly mottled with bright yellow and sometimes reddish yellow. A few lime concretions are occasionally encountered in the subsoil. The surface is flat to gently undulating. Low turtle-back ridges are sometimes encountered. The drainage is well established. Sugar cane, corn, cowpeas, peanuts, Irish potatoes, sweet potatoes, and a number of vegetables do well.

Ondawa silt loam.—The soil consists of a dark-brown mellow silt loam about 12 inches deep, underlain to 3 or 4 feet by a subsoil of the same silty materials, though of a gray to pale-brown or yellow color. There is usually a deep subsoil of gravel, which often comes to the surface in local areas of small extent. The type always occurs on first bottoms or the level floors of stream valleys. It is derived from the fine alluvial materials deposited by flood waters. It is an excellent soil for grass, both for hay and pasturage, and for corn, oats, potatoes, and heavy late truck crops.

Osage silt loam.—The Osage silt loam consists of a dark-gray or grayish-brown silt loam which gradually becomes lighter in color and usually heavier in texture with depth until at about 3 feet it is a drab or gray silty clay loam. The type varies considerably both as to texture and color, the above order in some places being exactly reversed. It constitutes the lighter alluvial soil which has been washed from the prairie uplands of dark-colored soils. Where its situation gives good drainage it is a very productive soil, giving large yields of general farm crops.

Papakating silt loam.—The soil is a dark-brown to black silt loam about 6 or 8 inches deep, underlain by a subsoil which is brown, yellow, or gray, though usually mottled yellow and gray, in color. The texture of the subsoil is somewhat variable; in some places it is heavier than the surface soil, in others lighter. The topography is level and drainage is poor. The areas vary in width from a few rods to a half mile or more along streams in the glacial region, which are annually overflowed. The type has a rather lower agricultural value than the corresponding member of the Genesee series, principally because of poorer drainage and the greater uncertainty of securing a matured crop. Its best use is for pasturage and hay meadows.

Pledger silt loam.—The soil to a depth of 10 to 14 inches consists of a black silt loam. The subsoil is a brown silt loam to silty clay, usually of a reddish or yellowish shade. The type occurs as narrow strips of well-drained soil on slight ridges along stream courses in the river bottoms, merging into the low, flat, poorly drained Trinity clay or Miller soils. The soil is very productive and is considered the best agricultural land of the river valleys, owing to its well-drained condition. It is locally called "peach land," owing to a common growth of wild peach tree (*Laurocerasus caroliniana* or *Prunus caroliniana*). The type owes its origin to high-water depositions of dark-colored material, largely from the Black Prairies of Texas, over reddish alluvial material from the Red Beds region. This type is limited in extent and is highly prized for corn, cotton, cane, and potatoes. Pecan, oak, ash, and wild peach constitute the principal timber growth. The soil has the feel of a silt loam, but small areas are found which analyze as light as a fine sandy loam.

Podunk silt loam.—The soil consists of about 12 inches of a dark-brown silt loam or heavy loam, underlain by lighter colored silt loam grading into drab and yellow mottled silt loam, which in turn, at an average depth of 20 inches, rests upon a very compact fine sand of a drab color. Finely divided mica is encountered throughout the soil and subsoil, which gives the material a slightly greasy feel. The type is alluvial in origin, and occupies level or depressed areas along streams. Artificial drainage is necessary and is accomplished both by open ditches and covered drains. It is best adapted to grass crops and produces large yields of hay. When moisture conditions are good large crops of ensilage are produced. Most of this land should be devoted to truck crops, such as celery and onions.

Robertsville silt loam.—This is a gray to grayish-brown, floury silt loam, underlain at about 6 to 12 inches by a light-gray to white, compact silt loam to silty clay loam, which passes at about 16 to 28 inches into a compact, impervious plastic clay of gray to yellowish-brown or chocolate-brown color, with a faint mottling of reddish brown. In the better drained situations both the soil and upper subsoil usually have more of a brownish color. Black oxide of iron concretions are usually present, the quantity increasing with depth. These are more abundant in the lighter colored, poorer drained situations. The flat surface and impervious subsoil renders the drainage quite poor in many places. This type occupies level or nearly level stream terraces and abandoned stream valleys no longer subject to overflow. If plowed when too wet the structure is very likely to become intractable with subsequent dry weather. Crops generally suffer more severely in wet years than during droughts, except those of unusual duration. Crops are rather late in getting started, owing to the cold nature of the soil. Ordinarily corn yields from 20 to 40 bushels, wheat 10 to 20 bushels, and oats 20 to 30 bushels per acre. Bluegrass, timothy, and white and alsike clover do well.

Sanders silt loam.—The soil to an average depth of 12 inches is a dark-colored or nearly black compact silt loam. There is frequently a dark mottling of brown and drab immediately beneath the surface soil. Pockets of sand or mantles of sandy material occur locally. Though the subsoil is variable, it is generally a dark-gray or brown mottled with drab silt loam passing into a brown fine sandy loam in the lower depths. The type is alluvial and occupies first bottoms. It is subject to overflow, but makes good crops of corn, cotton, and Johnson and Bermuda grasses. Heavy yields of sirup are also obtained.

Sarpy silt loam.—The soil of this type is a dark-gray to brown rather heavy silt loam which clods to some extent under cultivation. At an average depth of about 10 inches the color changes to a slightly lighter shade of brown or grayish brown without much change in texture. At about 18 inches or slightly deeper a more marked change in color and texture occurs, the material usually becoming a grayish-brown very fine sandy loam. The type is alluvial in origin and is found in the broad bottoms of the Mississippi, Missouri, and other streams of the loessial region. It occupies slight elevations representing the former sites of sandy swells or slight ridges which later have received the deposits of silt now forming the surface soil. On account of its relatively greater elevation and the looser structure and texture of the lower subsoil, the type is comparatively well drained and is very productive of the ordinary farm crops, such as corn, wheat, oats, clover, and alfalfa. It is subject to inundation only in times of unusually high floods.

Thompson silt loam.—This is a grayish-brown silt loam, underlain at about 6 to 10 inches by a yellowish silt loam or mottled yellow and gray heavy silt loam to silty clay loam. The subsoil frequently grades below into somewhat plastic silty clay. This soil occurs in the first bottoms of streams, where it is subject to frequent overflows. It has better drainage than the Bibb soils and would give better results with corn. Grasses, corn, and oats give fair to good results, according to drainage conditions, freedom from overflows, and methods of cultivation.

Tyler silt loam.—While there are many phases of this soil, in general the type consists of about 10 inches of a gray or dark-gray compact silt loam, underlain to about 15 inches by a lighter-gray or yellow compact silt loam. From 15 to 36 inches the subsoil varies from a mottled gray and yellow compact silty clay loam to a heavy plastic clay. The type is confined to second bottoms of streams in the Appalachian region. Drainage conditions are poor and the type is locally called "crawfish land." It is not well adapted to wheat, but fair yields of corn and oats are secured. The type is largely in meadow or pasture. Grass does well. Applications of lime and artificial drainage are necessary to put the land in proper condition for the general farm crops.

Wabash silt loam.—The type includes a dark-brown to black silt loam about 12 inches deep, underlain by a heavy silt loam of lighter color. Sometimes, however, the dark color extends to a depth of 3 feet or more. The soil is of alluvial origin. It occupies stream bottoms subject to overflow, and is often poorly drained. When well drained it produces heavy crops of corn and grass and fair yields of small grain.

Waverly silt loam.—The type consists of a grayish-brown to white silty loam, underlain at about 10 inches by a grayish or yellowish silty loam of closer structure. It occupies bottom lands and marshy depressions, and owes

its origin to sediments washed from loessial uplands. Corn is the principal crop.

Wehadkee silt loam.—The soil consists of a dark-gray or dull grayish-brown compact silt loam or silty clay loam, delicately mottled with rusty brown. In the higher situations the color is gray to light brown, while in the depressions and swales it tends more toward dark drab. The subsoil, beginning at an average depth of about 8 inches, is a dark-gray to drab compact silty clay loam to silty clay, usually mottled with shades of brown and yellow. The subsoil in many of the poorer-drained situations is intensely mottled drab, gray, yellow, and brown. The type occurs in first bottoms and over slightly higher areas, which might be considered as either high first bottoms or low second bottoms. The material is probably derived largely from the Piedmont. Overflows are frequent and water often stands on the flat areas and in depressions for long periods subsequent to the subsidence of stream floods. The reclamation of most of the type would probably necessitate diking the streams. Extensive ditching or tiling is essential to the establishment of good surface and underdrainage. The type is heavily timbered with gum, oak, ash, and poplar. Corn, oats, and grass would give good results under proper conditions of drainage.

Wheeling silt loam.—The soil to a depth of about 12 inches is a brown, mellow silt loam. The subsoil from about 12 to 16 inches is usually a somewhat lighter brown, compact but friable silt loam, and from this depth to the lower limit of the profile it is a brownish-yellow friable silt loam, the structure being somewhat more compact as depth increases. The type occurs on level or gently rolling terraces along river courses and is composed of alluvial material deposited at an early date. The soil is best adapted to potatoes, which are profitably grown, and also produces good crops of wheat, corn, and hay. Alfalfa has been grown to some extent. In general this type should prove very profitable for agriculture.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Wabash silt loam	Illinois 2, 3, 5, 6, 8, 9; Indiana 1, 3, 7, 8, 10; Iowa 2, 4; Kansas 2, 7; Kentucky 6; Minnesota 1; Missouri 1, 6, 7, 9, 10, 12, 13, 16, 17, 18, 19; Nebraska 3, 5, 6; Oklahoma 1; Wisconsin 5, 9.	976,476
Huntington silt loam	Alabama 3, 6, 11, 14, 15, 16, 20, 21, 23, 26, 28, 35, 37; Arkansas 1, 2; Georgia 18; Kentucky 2, 3, 7; Missouri 4, 8, 11, 22; Ohio 6; Pennsylvania 2, 18; Tennessee 2, 3, 7, 9, 11, 12; Virginia 9; West Virginia 1, 2, 5, 7, 8.	729,730
Waverly silt loam	Arkansas 4, 5; Illinois 1, 2, 4, 7, 9; Indiana 1, 2, 3, 9; Kentucky 1; Louisiana 6; Mississippi 4, 6, 13; Missouri 2, 4, 14, 21; Tennessee 8.	572,416
Laredo silt loam	Texas 5, 16, 27, 28	294,912
Lintonia silt loam	Illinois 9; Indiana 8; Kentucky 6; Louisiana 10; Mississippi 1, 6, 13, 19, 21; Missouri 4; Wisconsin 5, 7.	157,236
Miller silt loam	Kansas 10; Louisiana 3, 5, 10; Texas 12, 23, 24, 30, 31	154,816
Osage silt loam	Kansas 9; Missouri 3, 5	120,192
Cahaba silt loam	Alabama 1, 3, 14, 37; Mississippi 5, 9, 10, 12	94,656
Podunk silt loam	Connecticut 1; Massachusetts 1; New Hampshire 1	75,812
Iberia silt loam	Louisiana 10	65,792
Pledger silt loam	Texas 4, 12	57,600
Holston silt loam	Alabama 15; Virginia 9; West Virginia 1, 2, 5, 7	56,128
Tyler silt loam	Alabama 26; West Virginia 1, 2, 4, 5, 6, 7, 8	55,808
Holly silt loam	Alabama 8, 20, 26, 28; Georgia 18; Kentucky 4; Missouri 4	53,120
Genesee silt loam	New York 6, 10, 13; Pennsylvania 4, 7	50,432
Moshannon silt loam	West Virginia 1, 5, 7, 8	50,304
Kalmia silt loam	Alabama 14, 27, 37; Mississippi 9, 10, 20; South Carolina 10	43,712
Elk silt loam	Kentucky 4; Missouri 4, 8; Pennsylvania 18; West Virginia 1, 5	41,088
Ocklocknee silt loam	Mississippi 3, 9, 10, 12	39,360
Bibb silt loam	Alabama 3, 37; Mississippi 5, 9, 10	35,264
Ondawa silt loam	New York 4, 17	34,240
Robertsville silt loam	Missouri 8	32,192
Neosho silt loam	Kansas 1, 4	30,739
Wheeling silt loam	Ohio 6; West Virginia 2, 4, 6, 7	24,000
La Crosse silt loam	Wisconsin 9	23,808
Olivier silt loam	Louisiana 10	22,656
Congaree silt loam	Alabama 8; Georgia 5; North Carolina 11; South Carolina 9	19,072
Wehadkee silt loam	North Carolina 15	18,560
Sarpy silt loam	Missouri 1, 6, 8	17,728
Papakating silt loam	New Jersey 2; New York 5	16,448
Chariton silt loam	Missouri 12	15,936
Sanders silt loam	Texas 10, 24, 29	15,680
Biscoe silt loam	Arkansas 4	12,992

[1] For key to numbers in this column see p. 733.

Area and distribution of the silt loams—Continued.

Soil name.	State or area.	Acres.
Collins silt loam	Arkansas 4	8,576
Cumberland silt loam	Missouri 11; Tennessee 12	7,872
Hamlin silt loam	New York 10	6,144
Bastrop silt loam	Texas 3	6,080
Myatt silt loam	Mississippi 5, 10	5,888
Catalpa silt loam	Mississippi 15	5,056
Barbour silt loam	Pennsylvania 4	4,416
Birdsboro silt loam	Pennsylvania 3	3,840
Auglaize silt loam	Missouri 11	2,816
Altavista silt loam	North Carolina 11, 23	2,624
Buxin silt loam	Louisiana 4	2,560
Aroostook silt loam	Maine 1	2,432
Thompson silt loam	Mississippi 20	1,408
Abernathy silt loam	Alabama 10	832
Total		4,069,449

SILTY CLAY LOAM PHASE.

The silty clay loams comprise a moderately extensive group. They are developed in both first and second bottoms. These soils are adapted to practically the same crops as the silt loams, the essential difference being their greater tendency to bake, owing to the larger content of clay. They are a little more difficult to cultivate than the silt loams, but with proper cultivation and drainage the yields compare favorably with those of the corresponding members of the silt loam group.

Abernathy silty clay loam.—This is a dark-red or chocolate-red silty clay loam to about 6 to 25 inches. The subsoil is a compact yellowish-gray to nearly white silty clay loam of a floury feel, frequently grading below into mottled yellow and gray silty clay. The type is developed in overflowed bottoms of the streams in drainage basins which include extensive areas of Decatur soil. The soil portion represents material derived largely from Decatur soils, or at least enough Decatur material is present to impart the red color to the soil. The subsoil material is identical in appearance with that of the Holly silty clay loam. Much of the type is timbered. Corn, oats, and grass would do well with proper drainage.

Catalpa silty clay loam.—This type consists of a gray to dark-gray, friable silty clay loam, underlain at about 10 to 15 inches by a brownish sticky silty clay. In places the subsoil is quite dark and consists of material practically similar to the Trinity clay. The soil is typically developed in narrow strips of stream bottoms adjoining outcrops of "rotten limestone" or near areas of Houston chalk. The type owes its grayish color to depositions of comparatively fresh, light-colored calcareous material washed from these areas of "rotten limestone" or Houston chalk. This soil generally lies a little higher than the Trinity clay, and consequently has better drainage. The soil would be improved by plowing under such crops as melilotus, lespedeza, or soy beans. It is well suited to corn, cotton, alfalfa, Johnson grass, soy beans, lespedeza, and melilotus.

Congaree silty clay loam.—The soil is a brown to reddish-brown silty clay loam. The subsoil is slightly lighter in color and of very nearly the same texture, except in the occasional strata of sandy material encountered especially in the lower section of the subsoil. Particles of mica frequently occur throughout the soil mass. The type occupies first bottoms of streams. It consists of alluvial material derived mainly from the Piedmont soils. It is subject to overflow. With protection from overflow, such as can be secured by straightening and deepening the stream channels, the type can be made to produce excellent crops of corn, grass, oats, and forage crops. A large part of the type can be successfully used for these crops, the overflows not being so frequent as to render the utilization of the land unprofitable.

Frio silty clay loam.—The soil consists of 8 to 15 inches of grayish-brown to dark-brown silty clay loam. The subsoil is a gray to slightly yellowish gray or yellowish brown silty clay loam, and is usually more compact than the soil. Notwithstanding its high clay content, the soil is comparatively easy to cultivate when moisture conditions are favorable, but if stirred when wet it is apt to bake. It is well suited to irrigation, owing to its position in the valleys and

its level topography. Very little of the type is under cultivation, though a small acreage is being cleared.

Genesee silty clay loam.—This type is composed of a dark-brown or grayish-brown silty clay loam soil from 9 to 10 inches deep, overlying a plastic silty clay of a gray, bluish gray, or mottled gray and brown color. The natural underdrainage of the type is deficient, on account of the heavy character of the subsoil. The soil is found along streams and is subject to overflow. Following reclamation by drainage, it is well adapted to the heavier types of farm crops, and especially to grass.

Holston silty clay loam.—The soil to a depth of about 10 or 12 inches is a brown to dark-brown mellow silty clay loam. The subsoil is a yellowish-brown silty clay loam, which grades downward into compact silty clay. In the poorer drained situations there is sometimes a mottling of gray, drab, and rusty brown. This phase represents an approach toward the conditions obtaining in the Tyler soils. The type is developed on terraces well above overflow. The surface is smooth and the poorer drained areas should be ditched or tiled. This is a moderately good soil, well suited to such crops as grass, wheat, soy beans, tomatoes, potatoes, and cabbage.

Huntington silty clay loam.—This is a brown to dark-brown silty clay loam, underlain at about 8 to 15 inches by brownish silty clay. Through the soil section occasional layers of sandy material are encountered. The type occurs in first bottoms and is subject to overflow. The component materials have been washed from sandstone, limestone, and shale soils. With proper drainage the type is well suited to the production of corn, oats, wheat, grass, a number of forage crops, and cotton.

Iberia silty clay loam.—This is a dark-gray to black silty clay loam, underlain at about 6 to 12 inches by dark-yellow or grayish-yellow plastic silty clay, faintly mottled with rusty brown or drab. At about 30 inches this material varies from silty clay loam to very fine sandy loam. Lime concretions occur in the subsoil. This is one of the best general farming soils of the region, being well suited to sugar cane, corn, rice, and cowpeas. In some places this soil is somewhat similar to the Sarpy soils, in that its deep subsoil is lighter in texture than the soil. The subsoil, however, is more intensely mottled than that of the Sarpy series and contains a larger amount of lime concretions.

La Crosse silty clay loam.—The soil to a depth of about 12 inches is a black silty clay loam. This overlies gray or drab material of slightly coarser texture. The topography varies somewhat from level to hilly and the type often occurs in basin-shaped depressions, where the natural drainage is poor. The soil is adapted to corn, and when properly drained is a productive soil for small grain and hay and truck crops.

Laredo silty clay loam.—The soil is a dark-brown to black, heavy silty loam to silty clay loam to an average depth of 12 inches. The subsoil from 12 to 36 inches is a light-brown to drab silty clay loam which becomes lighter in color with depth. Both soil and subsoil are sticky and plastic when wet and bake badly on drying. The type occurs along old stream channels, where its topography is nearly level. It suffers but little from lack of drainage. The soil represents alluvium deposited along the former courses of the Rio Grande River. It supports a heavy growth of mesquite and cactus, and when cultivated produces excellent crops of corn, cotton, sugar cane, and vegetables, especially under irrigation. Small accumulations of alkali occur in depressions and very flat areas.

Olivier silty clay loam.—The soil is a grayish-brown to brown silty clay loam, averaging about 10 inches in depth. The subsoil is a mottled drab, yellow, and brown clay loam to silty clay. Spots of black material are occasionally found in the subsoil. The drainage is well established. Corn, cowpeas, rice, and sugar cane do well.

Osage silty clay loam.—The soil is a brown or gray silty clay loam about 20 inches deep, and contains a high percentage of silt. The subsoil is a light-brown or drab clay loam, which is slightly heavier than the soil in texture. The material contains a high percentage of organic matter, and the soil is friable and easily worked. The type occurs as level areas along streams and is alluvial in origin. It is subject to overflow, but the water drains away quickly, and the type is well adapted to the production of corn and sorghum. Alfalfa is also grown to a limited extent.

Sarpy silty clay loam.—The soil is a brown or dark-brown silty clay loam averaging something like 15 inches in depth. The subsoil is a light-brown very

fine sandy loam, usually mottled faintly with rusty brown or yellowish colors. The soil is most typically developed in a position intermediate between the higher front lands, such as the Yazoo, and the lower, heavier back land, and upon slight ridges. It has fair natural drainage, owing to its light subsoil and slightly elevated position. Ditches, however, are often necessary for the removal of heavy rains. The type owes its origin to deposition of silty clay loam over lighter textured material, such as old sand bars or sandy front lands. Cotton, corn, and oats give fine yields. Alfalfa should do well.

Sharkey silty clay loam.—The soil to a depth of about 10 or 12 inches consists of a light-brown or brown heavy silt loam to silty clay loam often slightly mottled with rusty brown. The subsoil ranges from heavy very fine sandy loam through silt loam to silty clay loam, usually of a light-brown color, mottled with drab and rusty brown and in places bluish gray. Fairly good yields of corn and cotton are secured. If protected from overflow and properly cultivated, the type would produce heavy yields of a number of crops. Cabbage, grass, and rice should do well.

Tyler silty clay loam.—This type includes a gray to grayish-brown compact silty clay loam, underlain at about 10 or 12 inches by a rather plastic silty clay of grayish-brown or pale-yellow color, sometimes mottled with gray in the lower portion. The material represents old alluvium occurring on second terraces and in deserted stream valleys. The type is sometimes called "crawfish" land. It is a rather clammy, cold-natured soil of moderate productive capacity. The type is best suited to grass. With liming, liberal incorporation of vegetable matter, and the establishment of good drainage conditions, general farm crops, such as corn, wheat, and oats, would give moderate to good yields.

Uvalde silty clay loam.—The soil to a depth of 10 to 15 inches is a gray to light-brown silt loam. This is underlain by brown or yellowish-brown silty clay loam. In common with nearly all the types of this arid region, both the soil and subsoil are highly calcareous, but contain little humus. According to the amount of organic materials present, the surface varies from light yellowish-brown to dark, the lighter color and lighter texture being found along the streams, while the darker, heavier soils occupy the low interstream plateaus. As a rule, the color and texture of the subsoil are more uniform than they are in the soil, the presence of white chalky mottling in the former being characteristic of the type.

Wabash silty clay loam.—To a depth of about 15 inches the soil is a dark-gray to almost black silty clay loam. The subsoil consists of a lighter gray clay, sometimes containing some silt and fine sand. The type occurs in broad bottoms, and is usually closely associated with other members of the Wabash series, especially the Wabash silty clay. It occupies positions somewhat more favorable to drainage than the Wabash clay. In the Missouri River Valley it is a good soil for general farm crops, yielding 25 to 50 bushels of corn and 15 to 30 bushels of wheat per acre.

Wallkill silty clay loam.—The surface soil of this type consists of from about 6 to 12 inches of silty clay loam, usually gray or dark brown, but having a rather wide range in color characteristics. The subsoil is a black muck or peat and extends to a depth of 2 feet or more. The topography is flat, and many of the areas of this type are subject to some overflow. In the drainage of this type care should be exercised not to lower the water table far into the muck subsoils, where capillarity is weak. The type produces excellent hay.

Wheeling silty clay loam.—This is a brown to dark-brown friable heavy silt loam to silty clay loam, underlain at a depth of about 10 to 14 inches by a lighter-brown or yellowish-brown compact silty clay loam. Beds of gravel in the substratum render drainage conditions good, except in local depressions, where there is not sufficient surface relief or drainage outlet to effect the proper removal of excess water. The soil is easily worked, and the topography is favorable to the use of any type of farm machinery. The soil occurs on terraces above overflow. It is admirably suited to the production of corn, oats, and cowpeas. A great many other crops do fairly well, including a number of vegetables and some varieties of apples.

Yazoo silty clay loam.—The soil is a brown silty clay loam, averaging about 18 inches in depth. The subsoil is a light-brown very fine sandy loam to silty clay loam, mottled with rusty brown, yellowish, and sometimes bluish colors. The soil is most typically developed in a position intermediate between the sandier Yazoo front lands and the heavy Sharkey clay of the lower back lands in the Mississippi flood plains. It usually has good drainage, owing to its position and the frequently sandy or fine sandy character of the subsoil. Where the

subsoil is heavier the type is sometimes quite impervious. In such areas ditches or tile drains are necessary. The soil gives good yields of corn, oats, and cotton. Alfalfa would give good results with the application of lime and inoculation, especially where the soil is freed from weeds by preliminary clean cultivation.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Uvalde silty clay loam	Texas 28	557,568
Frio silty clay loam	do	184,320
Laredo silty clay loam	Texas 5, 27	184,320
Sarpy silty clay loam	Kansas 5; Louisiana 4; Missouri 15, 16	66,304
Osage silty clay loam	Kansas 9; Missouri 5	42,816
Huntington silty clay loam	Alabama 20, 28	37,312
Iberia silty clay loam	Louisiana 10	25,664
Yazoo silty clay loam	Louisiana 4	21,248
Sharkey silty clay loam	Mississippi 1; Missouri 15	20,480
Holston silty clay loam	West Virginia 2	13,248
Abernathy silty clay loam	Alabama 26	10,816
Olivier silty clay loam	Louisiana 10	9,856
Congaree silty clay loam	North Carolina 3	7,360
Genesee silty clay loam	New York 10, 13; Pennsylvania 7	5,504
Tyler silty clay loam	West Virginia 7	4,864
Catalpa silty clay loam	Mississippi 10	3,968
Wheeling silty clay loam	West Virginia 2	3,392
Wabash silty clay loam	Missouri 1	2,752
La Crosse silty clay loam	Wisconsin 7	1,472
Wallkill silty clay loam	New Jersey 2	704
Total		1,203,968

[1] For key to numbers in this column see p. 733.

CLAY LOAM GROUP.

The clay loams are not nearly so extensive in the River Flood Plains province as the loams, silt loams, and clays, but are important in that they produce heavy yields of a number of the general farm crops when given proper drainage. They require strong implements and teams in their cultivation. Tillage operations are restricted to a narrower range than on the lighter types, since the material puddles if disturbed while in a soggy condition, baking with subsequent dry weather into a hard, unfavorable structure. Fertilizers are seldom needed, but applications of lime are beneficial in the case of most of those types not influenced by wash from calcareous soils. Corn, grass, sorghum, and a variety of forage crops are successfully grown. The clay loams of this province are rarely adapted to truck crops.

Altamaha clay loam.—The soil to a depth of about 14 inches consists of a dark-drab to bluish-black friable clay loam. The subsoil is a silty clay, ranging in color from dark drab through grayish mottled with reddish yellow to bluish drab below. The surface is level and the type is subject to tidal overflow with fresh or brackish river water. With the establishment of proper drainage, corn, oats, grass, and forage crops should do well. Rice gives good results.

Cumberland clay loam.—The soil to a depth of 8 to 12 inches is a brownish to grayish-brown clay loam. The subsoil to 36 inches or more is a reddish-brown to reddish heavy clay loam to clay. The soil contains small amounts of waterworn pebbles. The surface is gently rolling and drainage is good. The type occupies old river terraces and consists of colluvial material and ancient alluvium. Good yields of corn are secured, though the soil is largely utilized as pasture.

Dunning clay loam.—The soil is a very dark gray to black silty clay loam to clay loam, rich in organic matter. The subsoil, beginning at about 8 to 12 inches, is a mottled black and yellow clay which grades below into a yellowish clay frequently mottled with dingy yellow, bluish, and drab colors. The type is confined to the first bottoms of streams and is mainly subject to frequent overflow. It is of alluvial origin and is derived principally from sandstone, shale, and limestone soils. When properly drained, grains and grasses do especially well.

Genesee clay loam.—The soil is a heavy clay loam, dark in color, having a depth of about 10 to 12 inches. The subsoil is a heavy silty clay, bluish to drab

in color. The type is poorly drained and adapted to the production of hay and grazing.

Holly clay loam.—The type consists of a brown to gray clay loam to a depth of 10 inches, grading into a stiff, peculiarly mottled clay, the main color being drab or blue streaked with blue or gray. This material extends to a depth of 3 feet or more, and at about 10 feet assumes a uniform deep blue color. It is a first-bottom soil, generally poorly drained and occasionally subject to overflow. It is used to some extent for corn, wheat, and grass. The type is very much in need of drainage and lime.

Huntington clay loam.—The soil to a depth of 8 to 10 inches is a silty clay loam to clay loam of drab to dark-gray color. The subsoil is a drab to yellow, slightly plastic silty clay loam to clay. Yellow and drab mottling is quite common in the poorer drained areas. The soil is of alluvial origin, and represents the wash from shale sandstone and limestone formations. It occurs principally as first bottoms and is subject to overflow. A small part of the type lies above overflow upon indistinctly developed second terraces. Corn, oats, wheat, and grass do well.

Laredo clay loam.—To an average depth of 10 or 12 inches this soil is a heavy light-brown silty loam which contains enough clay to make it sticky and tenacious when wet and to cause it to bake and sun-crack upon drying. The subsoil is a brown silty loam of slightly heavier texture, which rapidly becomes heavier as depth increases, until at about 20 inches it changes to a dark-brown stiff, compact, silty clay. The type is alluvial, being formed of old flood-plain deposits. It occupies shallow depressions adjoining the rolling upland. A large percentage of the type is under cultivation, and the greater part of the cultivated area is under irrigation. The soil is adapted to the production of onions. Corn, cabbage, beets, sorghum, cowpeas, and sweet potatoes are all successfully grown. Cowpeas do particularly well on both the irrigated and unirrigated areas.

Myatt clay loam.—This soil to a depth of 3 to 5 inches is a gray or brownish-gray silt loam to silty clay loam, passing into a light-gray mottled plastic silty clay which seems to contain a large percentage of fine sand. Under cultivation the soil has a tendency to clod. It occurs as low, level areas generally bordering stream bottoms and only a few feet above overflow. The natural growth consists of post, red, Spanish, pin, water, and white oaks, hickory and pine. A few areas are cultivated, and, except during wet seasons, the yields are better than on the lighter uplands. Cotton, corn, and oats are grown.

Ocklocknee clay loam.—The soil is a brown or dark-brown clay loam or silt loam, varying from 8 to 18 inches and averaging about 10 inches in depth. The subsoil is a brownish, drab, or gray clay loam or silty clay loam to a depth of 36 inches or more. Beds of sand are sometimes encountered at 3 feet or more. The type occurs as level or gently undulating first bottoms along streams. The natural drainage is poor and crops are somewhat damaged by annual floods. Along the smaller branches there is little danger from floods. The type is alluvial in origin. It is better adapted to corn than to cotton, although good yields of both are obtained. The soil would be greatly benefited by open drains and also by installing tile drainage in places. Grass and corn do well.

Sanders clay loam.—The soil to a depth of about 12 inches is a dark-brown clay loam. The subsoil to 3 feet or more is a grayish or yellowish silty clay. The type occurs in limited areas along the edges of bottoms. Its formation is due in part to flood action and in part to alluvial wash from the slopes. Drainage is usually fair. The soil is adapted to cotton and corn, and if artificially drained it should be suited to the production of alfalfa.

Sarpy clay loam.—The soil is a stiff, waxy, gray to brown or nearly black clay loam from 12 to 24 inches, with an average of about 20 inches in depth. The subsoil consists of gray or yellow fine silty sand or fine sandy loam. This is a bottom-land type occupying depressed areas and generally requiring artificial drainage. It is of recent alluvial formation and is undergoing some change. When drained it is an excellent corn soil, the average yield per acre being about 50 bushels. Where not overflowed the type is used to some extent for alfalfa, and excellent yields are secured.

Sharkey clay loam.—The soil varies from a dark-brown heavy loam to a light-brown or grayish-brown light clay loam. The subsoil is a plastic clay loam or clay mottled with drab, bluish, and rusty brown. The type represents in places a gradational soil between the Yazoo or higher lying and lighter textured river-front soils and the heavy clay lands such as the Sharkey clay. The topography ranges from flat to slightly ridgy, being cut in places by old stream channels.

The type is well adapted to corn, cotton, and cabbage. Grass, sugar cane, and rice should do well.

Wabash clay loam.—The soil consists of a dark-gray to black silty clay loam from 8 to 18 inches deep. In local areas it varies from a heavy silt loam to a silty clay. The type is marked by small mounds rising from 1 to 3 feet above the general surface level. On these mounds the soil is generally a silt loam, and on their slopes a silty clay loam, while between them it is a silty clay. The subsoil is composed of a gray or yellowish-gray, plastic, heavy silty clay loam or silty clay, or of the former grading into the latter at an average depth of 20 inches. The type occupies level or slightly rolling bottom lands which are much better drained than Meadow. It is alluvial in origin.

The soil is best adapted to the production of grass for pasture, and a great part of the type is used for this purpose. Under ordinary management the tilled areas produce only fair yields of general farm crops. Higher yields are obtained where artificial drainage is employed.

Waverly clay loam.—The soil to a depth of about 6 inches is a light-brown to grayish, heavy silty clay loam, often containing small iron concretions over the surface and through the soil. The soil becomes heavier with depth and grades into a very heavy silty clay loam. At a depth of from 12 to 20 inches the subsoil is a sticky, mottled clay, usually containing small iron concretions and becoming stiffer and more tenacious as depth increases. There is apparently little organic matter in the soil, except in swampy areas. The compact nature of the soil, together with its level topography and low-lying position, often makes drainage difficult. The type is alluvial in origin, having been formed largely through the reworking by stream action of the loessial material from the uplands. The soil is best adapted to clover, timothy, and redtop. The other crops grown are tobacco, wheat, and corn, the yields depending on thoroughness of drainage and cultivation. Where drainage is not practiced the land is either covered with a growth of scrub oak or used exclusively for pasture.

Wickham clay loam.—The soil is a pale-yellow or gray loam or very fine sandy loam, passing at about 6 inches into a yellow clay loam which extends to a depth of about 12 inches. The subsoil varies from slightly friable to stiff, yellow, olive, or mottled clay or reddish clay, containing a high percentage of fine sand and fine flakes of mica in its lower depths. The type occupies level or slightly rolling terraces and is generally well drained. It is derived from old alluvial sediments. The soil is very productive, yielding in good seasons from 40 to 60 bushels of corn, from 15 to 30 bushels of wheat, 50 or more bushels of oats, and from 1 to 2 tons of hay per acre.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Waverly clay loam	Alabama 17; Illinois 7; Indiana 2, 8; Missouri 14	105,280
Ocklocknee clay loam	Alabama 29; Mississippi 3, 12, 17	46,656
Wabash clay loam	Indiana 3; Iowa 3; Missouri 1, 21; North Dakota 2	41,280
Sarpy clay loam	Missouri 1, 10; Nebraska 5	19,776
Huntington clay loam	Arkansas 2; Pennsylvania 5	19,008
Sharkey clay loam	Mississippi 1	6,848
Myatt clay loam	Mississippi 15	4,096
Wickham clay loam	Virginia 6	2,176
Sanders clay loam	Texas 10	1,664
Genesee clay loam	New York 6	960
Holly clay loam	Kentucky 3	896
Dunning clay loam	Pennsylvania 2	768
Laredo clay loam	Texas 16	704
Altemaha clay loam	Georgia 10	640
Cumberland clay loam	Virginia 9	192
Total		250,944

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The clays comprise the largest total area of differentiated soils of the River Flood Plains province. They are most extensive in the first bottoms of the larger streams, where the sediments have been deposited by relatively slow moving water.

These are the most difficult soils of the province to cultivate, heavy draft animals and strong tools being necessary to maintain requisite tilth. In most cases tillage is restricted to a narrow range of moisture conditions, for the reason that the soils are likely to puddle and to assume on drying a hardened condition favorable to the formation of intractable clods. Some types, however, such as the Sharkey clay, can best be cultivated either when in a very wet or a very dry condition, because they are extremely plastic and sticky when only moderately moist. Since the material is inclined to crack into small aggregates on drying out, baking is not so apt to follow when the soil is disturbed in a wet condition.

The clays are largely suited only to such crops as rice, sugar cane, corn, grass, and certain forage crops. Some of those types, such as the Miller clay, which contain considerable lime and assume a granular structure on drying out, can be successfully used for a few late vegetables, particularly cabbage and tomatoes. The early maturing varieties of cotton do well on the clays, but the crop is often damaged severely by the boll weevil. As a rule this group of soils gives heavy yields when properly protected from overflow or during years when disastrous overflows do not occur during the growing season. They do not require fertilization, but certain members not derived from calcareous soils are benefited by applications of lime.

The Sharkey clay is the most extensive series of the entire province. It comprises the greater part of the Mississippi bottoms. The Trinity clay is an extensive soil along streams flowing through and issuing from the regions occupied by the Houston soils. The Wabash and Waverly clays have a wide development in the bottoms of streams of the loessial region, while the Miller clay is the most extensive bottom-land type along streams heading in the Red Beds region. The Ocklocknee clay is the most widely developed representative of this group in the first bottoms of the Coastal Plain streams, while the Cahaba is the most extensive clay of the Coastal Plain terraces.

Altamaha clay.—The soil consists of a heavy, plastic clay, except in the surface inch or so, which is frequently a dark clay loam. Below this superficial layer the color of the material ranges from dark drab or dark slate blue to bluish drab or bluish gray, sometimes mottled with yellow. Lime concretions are occasionally encountered at lower depths. Cultivation is difficult when the soil is wet on account of its stickiness, and when dry on account of its hard, intractable structure. Ordinarily this soil is poorly drained and subject to tidal overflow with fresh or brackish water. The type occurs in river bottoms, and in places it has been protected from overflow by dikes and utilized for rice. It is associated with the Georgetown soils lying usually a little higher. The type is best suited to rice and oats.

Bastrop clay.—The soil to a depth of 6 to 10 inches is a dark-gray clay loam to heavy clay. The subsoil to 36 inches is a dark-gray to dark-brownish, compact and plastic clay. Both soil and subsoil contain large amounts of silt and organic matter. The soil bakes badly and requires careful cultivation to maintain proper tilth. This is an alluvial soil, occurring on terraces having comparatively level topography with occasional swells or gentle depressions. Drainage is not exceptionally good and much of the type is greatly benefited by surface ditching, though but little damage is ever done by overflows or by excessive moisture. It is probably the strongest soil of these bottoms and is well adapted to general farming. Cotton, corn, and sorghum are the principal products, though corn does better than cotton. Alfalfa is successfully grown.

Bibb clay.—The soil consists of a mottled gray to nearly white, compact silty clay from about 4 to 8 inches deep, with a subsoil of light-gray to nearly white, compact, plastic silty clay, more or less mottled with yellowish or brownish colors. Owing to its intractable structure, the soil clods badly and bakes in dry weather. It is a poorly drained first-bottom alluvial soil derived from Coastal Plain material. In good seasons both cotton and corn do well, but the average yields are rather low on account of poor underdrainage and overflows. Grass does well. With the establishment of better drainage and liberal applications of lime this could be made quite a productive soil.

Cahaba clay.—This type consists of a stiff, reddish-brown to red clay, sometimes slightly streaked and mottled with yellow. This is frequently overlain by from 1 to 4 inches of a brownish material of lighter texture. The presence of mica flakes frequently imparts a greasy feel to the subsoil. The type is alluvial in origin, and occupies terraces along streams in the Coastal Plains. The original growth comprised shortleaf pine, gum, and oak. The type is very productive, making excellent yields of oats and cotton with but little fertiliza-

tion. Crops sometimes suffer during drought when the soil has not been thoroughly broken and kept well mulched.

Calhoun clay.—The soil consists of a gray heavy clay, 2 to 6 inches deep. In places to a depth of 12 inches it is a gray silty clay. The subsoil is a very heavy, tenacious, waxy clay of gray or drab color. Small iron concretions are found throughout the soil and subsoil. The type occupies low-lying upland areas intermediate between higher-lying uplands and bottoms, which indicates an ancient alluvial origin. It is nearly level and poorly drained. Water stands for long periods during wet seasons, though the type is never overflowed. When well drained it should prove a good soil for cotton. The type supports a heavy growth of white and black oak.

Cameron clay.—The soil is a dark-brown to black heavy clay to an average depth of 12 to 15 inches. The subsoil from 12 to 36 inches is a heavy clay of lighter color than the soil. The soil puddles and bakes badly. Small lime concretions frequently occur in the deeper subsoil. The type occupies bottom-land depressions on either side of abandoned stream courses and has very poor drainage. Rice culture has been discontinued on account of alkali accumulation, but where well drained good yields of the general farm crops are secured.

Congaree clay.—The type to a depth of 3 feet or more consists of light-brown or chocolate-colored clay, containing a large percentage of silt. The material from 8 to 36 inches is lighter in color and a little heavier in texture than the top soil, and occasonally a thin seam of very fine sand occurs. The swells and hummocks contain a little more sand than the low-lying areas. Particles of mica brought down from the Piedmont are scattered throughout the soil section. The type occurs in the first bottoms of streams flowing through and issuing from the Piedmont. Frequent overflows render a large part of the type uncertain for crops. It is adapted to general farm crops, and good yields of corn and oats are secured in favorable seasons. The original timber growth includes gums, hickory, cottonwood, and sycamore, with some pine and cypress.

Dunning clay.—The type consists of a dark grayish brown to black silty clay, underlain at about 12 inches by tenacious, plastic clay of drab to yellowish-brown color. The soil is sticky and assumes a compact, intractable structure on drying out. The type occurs in the overflowed bottoms of streams and abandoned stream valleys subject to overflow. The organic-matter content is high, and the soil when properly drained gives good results with corn, oats, and wheat.

Elk clay.—The soil is a grayish to light-brown silty clay. The subsoil is a mottled gray and yellow, somewhat plastic clay or silty clay. The soil is alluvial in origin, having been derived from the limestone, sandstone, and shale soils of the Appalachian Mountains and Limestone Valleys. It occupies second terraces lying in part completely above overflow and in part above normal overflow. It is well adapted to corn, grain, and grass.

Frio clay.—The soil consists of dark-gray or black clay or clay loam, 10 inches deep, grading into stiff, tenacious clay, slightly lighter in color than the soil and becoming heavier in texture as depth increases. When wet the soil is sticky, plastic, and tenacious, and on drying it becomes baked and sun-cracked. Because of these characteristics the soil is difficult to work, except when in the proper state of moisture.

Georgetown clay.—The soil to an average depth of about 6 inches is a silty clay of mottled drab and rusty-brown or reddish-brown color. In places the drab predominates, giving the soil when dry a grayish color. In other places the rusty brown or reddish brown predominates, so that the dry surface resembles closely that of the Congaree soils. Upon close inspection, however, the mottled color is nearly always found to be present. The subsoil is a plastic, sticky silty clay of mottled reddish-brown, drab, bluish, and gray color. This general mottling may continue to a depth of 3 feet, but often the lower subsoil, which is saturated with water, is more of a bluish color. The type occurs as alluvial lands near the mouths of streams rising in the Piedmont. It is subject to fresh or tidal overflow with fresh or slightly brackish water. The type grades into tidal marsh, which occurs nearer the ocean and is subject to daily inundation of salt water. This soil was formerly extensively used for the production of rice where protected from overflow by dikes, but recently this industry has declined. By strengthening the dikes and installing underdrainage and pumping to lower the level of the water table good results could be had with such crops as sweet and Irish potatoes, spinach, cabbage, cauliflower, late tobacco, corn, oats, peas, beans, sugar cane, and certain bottom-land varieties of cotton. Applications of acid phosphate to

hasten maturity and the addition of lime to correct possible unsanitary conditions would likely be profitable.

Griffin clay.—The soil is a brown or mottled, heavy, impervious clay mixed with coarse sand and medium to fine water-worn gravel. The gravel is sometimes absent, but in places it ranges as high as 40 per cent, and averages 10 per cent of the soil mass. A substratum of gravel is generally encountered at from 5 to 10 feet. The presence of this gravel in the soil section and substratum makes the type more friable and assists its natural drainage. The type occupies broad first bottoms and is of alluvial origin. Corn is the principal crop grown on cleared areas, though wheat also yields well.

Huntington clay.—The soil is a dark-brown to nearly black silty clay loam to silty clay. The subsoil is a light-brown to dark-brown silty clay. The type occupies first bottoms subject to overflow. The material is derived principally from sandstone, shale, and limestone soils of the Appalachian Mountains and limestone valleys. When the soil is properly drained corn and grass do well. Late truck crops, such as cabbage and tomatoes, are sometimes grown.

Iberia clay.—The soil to a depth of 5 or 6 inches consists of a heavy, waxy, black clay. The subsoil is a heavy, tenacious clay of grayish-yellow color, faintly mottled with dark-drab, grayish-yellow, and bluish colors. Between 30 and 40 inches the subsoil becomes lighter in texture. Owing to the sticky character and black color of the soil, the type is locally styled "black waxy land," "terregras," and "blackjack land," the latter term referring to the character of the soil and not to timber growth. Lime concretions occur in the subsoil. The type occupies low, flat, poorly drained areas. It is a strong soil, producing good crops of corn and sugar cane in years of moderate rainfall. With the establishment of good drainage it is the best corn soil of the region. Rice also does well.

Kalmia clay.—This soil consists of a thin mantle of grayish or yellowish, compact very fine sandy loam to silty loam, resting upon yellow, very fine sandy loam to silty clay, which in the lower section is mottled with grayish and reddish colors. It occupies second terraces of streams, lying above overflow. The type is rather difficult to cultivate, but when brought into a good condition of tilth gives fairly good yields of oats, corn, cotton, and forage crops.

Laredo clay.—The soil consists of a light-brown to drab clay loam about 10 inches deep. The upper 2 or 3 inches of the soil often contains enough fine sand to give it a slightly gray appearance, but the soil becomes stiff and heavy at a very slight depth, and at 6 to 10 inches it contains little or no fine sand. The subsoil to a depth of 3 feet or more is a light-brown to drab, stiff, heavy clay. In the lower part of the soil profile the material is so dry and compact that it is difficult to penetrate with a soil auger. The type is comparatively level. It was formed from materials washed from the residual prairie regions mixed more or less with silt and clay which have been worked down from the neighboring hills and ridges. None of the type is under cultivation. It supports a dense growth of mesquite and other native vegetation.

Miller clay.—The soil to a depth of about 10 inches is a brownish-red or chocolate-colored clay. This is underlain by a stiff, tenacious, brown or red clay subsoil. In some cases a yellow fine sandy loam is found at a depth of 3 feet, while in depressed areas subject to frequent and long-continued overflows a drab or blue clay may form the deeper subsoil. This type represents the finest materials brought down by streams from the Permian Red Beds and deposited during overflows. It is a strong soil for corn, cotton, and sugar cane, and where well drained large yields are secured. The timbered areas support a heavy growth of oak, gum, whitewood, and cypress, with a dense undergrowth of shrubs, vines, and briers. The usual high content of lime gives the soil, especially when dry, a more friable structure than it would otherwise have.

Moshannon clay—erosion phase (includes some Holly clay).—This type is developed in stream bottoms which are subject to overflow. The surface configuration is marked by slight hummocks and shallow depressions. The soil in the depressions is poorly drained and represents mainly Holly silty clay, which is a compact, gray silty clay loam or silty clay, underlain by clammy, rather plastic silty clay, of mottled gray, rusty-brown, or drab color. The structural conditions are poor, and the soil is best suited to grass. On the slight ridges the soil is a chocolate-brown silty clay loam, underlain by mottled gray and chocolate-brown or red silty clay, representing Moshannon silty clay. The material is fairly well drained and is well suited to general farm crops. These two

soils occur in areas so small and in such close association that it is impossible to separate them on the scale of an inch to the mile. They are so patchy in occurrence that it is usually impracticable to farm them differently, the whole often being turned over to pasturage or hay lots.

Ocklocknee clay.—This type consists of a dark-brown heavy clay loam to clay, resting on a brownish, stiff, tenacious clay, mottled with rusty-brown and yellowish colors. The type is confined to overflowed first bottoms. It is a strong soil and produces good crops of corn and sugar cane when not too severely overflowed.

Osage clay.—The soil to about 18 inches is a black, heavy silty clay or clay. This is underlain by a bluish-drab clay subsoil. Generally there is little difference between the soil and the subsoil. The type is of alluvial origin and represents the heaviest material washed from the prairie uplands of sandstone and shale soils. Practically all of the type is subject to deep and prolonged overflows, but when drained and protected from floods large yields of corn and other crops are secured.

Papakating clay.—To the depth of about 7 inches the soil is a dark-brown, dark-gray, or black heavy clay loam or silty clay. The subsoil is a lighter gray or bluish-gray, plastic, tenacious, heavy clay, so dense and impervious in structure as to impede the movement of water through it. No stone or gravel occurs. The type occupies level to slightly basin-shaped depressions in areas through which at present only small drainage ways pass. The origin of some of the soil is somewhat obscure, though it is believed that the surface of the type at least is predominantly alluvial. The subsoils in some of the areas may have been deposited as lacustrine sediments. The type is at present subject to overflow at infrequent intervals. It is poorly drained, and is largely covered with marsh grass and other water-loving vegetables. When well drained the soil is well adapted to the production of hay and some of the heavier grain crops. The type is used principally for pasturage.

Sanders clay.—The soil to a depth of 6 or 8 inches consists of a grayish silty clay. This is underlain to 3 feet or more by an ashy-gray, sticky, impervious clay, which becomes almost white on exposure. The subsoil is frequently faintly mottled with shades of yellow and brown. The soil is alluvial in origin and is typically developed along the larger streams. The surface is level and the type is subject to such frequent overflow that no crops are grown. Under present conditions it is not a desirable soil for agricultural purposes, but if artificially drained and protected from floods it would be well adapted to grass and some of the staple crops of the region.

Sarpy clay.—The soil consists of a yellowish-brown to grayish-brown or sometimes drab, heavy, compact silty clay, from about 15 to 24 inches in depth. The subsoil is a silt loam to very fine sandy loam of friable structure. Rusty-brown and drab mottlings are common in the subsurface soil and subsoil. The type is developed in depressions and flat areas within the river bottoms. Corn has been grown with success on this soil where drained, yields of 50 to 75 bushels having been obtained. With the establishment of thorough drainage alfalfa would probably do well.

Sharkey clay.—The soil is a drab to mottled drab, yellow, and rusty-brown, stiff, waxy clay, about 8 inches deep, frequently containing iron concretions. The subsoil is a stiff, impervious clay similar to the soil. The surface suncracks readily. The type is locally known as "buckshot land." It is a poorly drained soil, occupying the lowest portions of river bottoms, and is subject to annual overflow. When diked and well drained it is a strong soil, suited to corn, sugar cane, cotton, and rice.

Trinity clay.—The soil to a depth of about 8 to 15 inches is a dark-gray to black stiff clay loam to clay. The subsoil is a drab to gray, heavy, very stiff clay, usually lighter than the soil in color, though the dark color may sometimes extend to a depth of 3 feet or more. The soil is quite plastic when wet and is subject to hard baking and cracking on drying out. Intractable clods are formed when the soil is plowed while too wet or too dry. The type occupies comparatively level bottoms along the streams in and issuing from the calcareous prairies of the Gulf Coastal Plain. It is alluvial in origin, being derived mainly from calcareous prairie lands. The type is productive, and where well drained and protected from overflow is suited to corn, cotton, Johnson grass, and alfalfa.

Wabash clay.—The soil is a drab to black heavy clay loam, 6 inches deep, containing considerable organic matter. The soil sun-cracks badly, forming small aggregates which cause a close resemblance to "buckshot land." The subsoil is a gray or drab, gray clay, sometimes resting upon fine sand at a depth of about 5 feet. The type occupies low areas to the rear of front lands and higher ridges in open forest lands in river deltas. It usually requires drainage. In the northern areas the soil is adapted to corn; in the southern areas it is a good cotton soil, yielding about 1¼ bales per acre.

Waverly clay.—The soil consists of a light-brown or gray clay loam about 10 inches deep. It contains a high percentage of clay and silt, and rapidly becomes stiffer and more tenacious with depth, grading into a heavy, tenacious clay subsoil of brown or drab color, which is often mottled in the lower depressions. A few small iron concretions are present in both soil and subsoil, especially in the swampy areas. The type is alluvial in origin, and occupies low bottom lands subject to overflow. The occasional addition of new material to the soil tends to maintain its productiveness. This soil is best adapted to corn, and when well drained and cultivated it yields as much as 60 bushels per acre. Wheat, oats, and tobacco, when not damaged or destroyed by floods, do well. Clover, timothy, and other grasses give large yields.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Sharkey clay	Louisiana 4, 6, 7, 10, 11, 12, 13; Mississippi 1, 6, 19, 21; Missouri 4, 15; Texas 14, 18, 23.	1,572,436
Trinity clay	Alabama 17, 30; Mississippi 3, 10, 12, 14, 15; Texas 1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 14, 20, 24, 26, 27, 28, 29, 31, 33.	1,231,424
Wabash clay	Illinois 2, 4, 7, 9, 10; Kansas 1, 4; Louisiana 6, 7; Mississippi 6; Missouri 1, 4, 6, 8, 10, 12, 13, 14, 16, 17, 18, 19; Nebraska 5; North Dakota 2; Ohio 10; Oklahoma 2.	362,291
Ocklocknee clay	Alabama 2, 3, 5, 13; Florida 2; Georgia 1; Mississippi 3, 5, 8, 9, 10, 14, 15, 20.	301,184
Miller clay	Arkansas 3; Louisiana 3, 5, 14; Oklahoma 1; Texas 4, 24, 31	269,504
Waverly clay	Arkansas 4; Indiana 2, 8; Kentucky 1, 6; Ohio 10	201,152
Cameron clay	Texas 5, 27, 28	152,064
Cahaba clay	Alabama 13, 18, 30; Georgia 8; Mississippi 10, 14, 20; North Carolina 7.	109,056
Laredo clay	Texas, 5, 16, 27	93,312
Georgetown clay	Georgia 3, 10; South Carolina 10	69,952
Congaree clay	Mississippi 11; North Carolina 7, 22; South Carolina 10, 14	52,832
Sarpy clay	Kansas 5; Louisiana 4; Missouri 8, 15, 16	49,920
Huntington clay	Alabama 21, 25, 30; Arkansas 1	40,064
Frio clay	Texas 28	37,952
Sanders clay	Texas 10, 20, 29	26,304
Osage clay	Missouri 3	23,232
Calhoun clay	Arkansas 4	12,672
Bastrop clay	Texas 3	12,352
Iberia clay	Louisiana 10	10,112
Papakating clay	New York 5	9,984
Kalmia clay	South Carolina 6	9,280
Bibb clay	Mississippi 15	7,360
Elk clay	Alabama 19	6,080
Moshannon clay	West Virginia 7	4,608
Griffin clay	Indiana 8	1,600
Dunning clay	Missouri 8	384
Altemaha clay	Georgia 10	384
Total		4,667,495

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

Soils of silty clay texture are inextensive in the Flood Plains province. They have practically the same adaptation and crop value as the clays, but they are a little easier to maintain in a good condition of tilth on account of the granulating effect of the silt present.

Huntington silty clay.—The soil is a brown, quite compact silty loam to silty clay loam, about 12 inches deep. The subsoil is a compact silty clay of somewhat lighter brown color. The type occurs in first bottoms and is subject to overflow. Along some of the smaller streams the texture varies, with a tendency toward a larger percentage of sand. The topography is level to slightly rolling,

and surface and underdrainage are fairly good. Though the soil has a decided tendency to clod, good tilth can be maintained by careful management. It is considered a valuable type for corn and hay, producing an average yield of 50 bushels of the former and 1½ tons of the latter crop.

Laredo silty clay.—The soil is a heavy, brown silty clay, about 15 inches deep. This grades into a lighter-colored, stiff, compact silty clay subsoil. At 25 to 30 inches the subsoil grades into a light-brown silty loam. The soil does not bake seriously. The surface is nearly level, but a gentle slope toward the adjacent lowlands gives it fair drainage. The type was formed by deposits when these areas were overflowed by the river and represents ancient alluvium. Alkali occurs in small depressions. Under irrigation the soil produces good yields of corn, cotton, sugar cane, and vegetables.

Miller silty clay.—The soil of the Miller silty clay, to an average depth of 14 inches, is a heavy, reddish-brown silty clay. The subsoil is typically a reddish-brown silty clay loam, though local pockets of sand or bands of clay occur below 30 inches. The high lime content is due in part to the presence of snail shells. The type is alluvial in origin and consists of stream-deposited material, which has been derived from the Permian Red Beds. It is an excellent general farm soil and produces large crops of corn and cotton, although the yields of the latter crop have been much reduced in recent years by boll-weevil ravages. Alfalfa does well. Irish potatoes constitute the most important crop.

Rio Grande silty clay.—The soil consists of 12 inches of dark-brown to black silty clay or clay, grading into a subsoil which becomes lighter in texture with depth. The surface bakes badly. Low ridges of fine sand and silt occur throughout the type. It occupies the lower terraces in the larger bends of the Rio Grande River and is subject to occasional overflow. The soil is derived from recent alluvium. Most of the type supports a heavy growth of palms, tules, cane, and marsh grasses. Cotton and corn produce fair yields on the better drained areas. No irrigation is practiced.

Sarpy silty clay.—The type is a dark-brown to almost black silty clay, about 14 inches deep, underlain by a lighter-colored fine sandy loam. Thin layers of clay are sometimes encountered in the subsoil. The soil cracks and breaks into cubes upon drying. It is difficult to handle, but when properly cultivated it is a productive soil.

Wabash silty clay.—The soil varies in depth from 12 to 24 inches and consists of a dark-brown medium to heavy silty clay loam. The subsoil to a depth of 36 inches is a compact and rather heavy brownish or yellowish silty clay loam or silty clay. The type occupies a rather low position in stream valleys and on gentle slopes. In the former position its surface is very nearly level or gently sloping. It occurs as first bottoms and is subject to overflow. The soil is of alluvial origin. Where protected from overflow some of the areas are adapted to the production of corn and alfalfa. Alfalfa should be grown on the gentle slopes where drainage is good. Wheat and oats are also grown. Some of the heavier types of vegetables do well.

Area and distribution of the silty clays.

Soil name.	State or area.[1]	Acres.
Miller silty clay	Texas 12	124,480
Huntington silty clay	Tennessee 1; West Virginia 6	47,936
Rio Grande silty clay	Texas 5, 27	34,560
Wabash silty clay	Kansas 7; Missouri 1, 12; Oklahoma 1	14,976
Sarpy silty clay	Missouri 6, 10	5,440
Laredo silty clay	Texas 5	448
Total		227,840

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Meadow	Alabama 1, 2, 3, 4, 5, 8, 9, 12, 13, 14, 15, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 36, 37; Arkansas 2; Connecticut 2; Delaware 1; Florida 1, 2, 5, 6; Georgia 1, 4, 6, 7, 8, 9, 11, 12, 14, 15, 16, 19; Illinois 3, 11; Indiana 1, 4, 6; Iowa 1, 2, 3; Kansas 10; Kentucky 3; Louisiana 2, 3, 4, 5, 7, 9, 10, 12, 13, 14; Maryland 1, 2, 4, 5, 6, 7, 8, 9; Massachusetts 2; Michigan 1, 2, 3, 5, 6, 7, 8; Minnesota 1, 2, 4, 5; Mississippi 2, 4, 5, 6, 7, 9, 10, 11, 13, 19, 20, 21; Missouri 1, 18, 20; New Hampshire 1, 2; New Jersey 1, 2, 3; New York 1, 2, 4, 5, 7, 8, 12, 15, 16, 18; North Carolina 1, 2, 3, 4, 5, 10, 11, 13, 14, 15, 17, 18, 22, 26; North Dakota 2, 5, 8, 9; Ohio 1, 3, 7; Oklahoma 2; Pennsylvania 3, 6, 9, 10, 12, 17; Rhode Island 1; South Carolina 1, 2, 3, 5, 9, 11, 15, 17; Tennessee 5, 10; Texas 1, 3, 6, 10, 11, 13, 14, 15, 18, 19, 20, 21, 24, 29, 32, 34; Vermont 1; Virginia 1, 2, 3, 4, 5, 6, 7, 8, 9, 11; West Virginia 3, 9; Wisconsin 5, 6, 7, 9, 12, 14, 15.	3,395,919
Swamp	Alabama 1, 2, 13, 14, 18, 29, 37; Arkansas 3; Connecticut 1; Delaware 1; Florida 4, 5, 6, 7; Georgia 2, 3, 5, 10, 13, 15, 16, 17, 19; Louisiana 1, 3, 5; Maryland 2, 9, 10; Massachusetts 1; Mississippi 4, 18; New York 6; North Carolina 6, 7, 8, 9, 15, 19, 20, 21, 22, 23, 24, 25; South Carolina 6, 7, 8, 10, 12, 14, 16; Texas 3; Virginia 5, 6, 10, 12.	1,687,464
Gravelly soils undifferentiated	Texas 28	177,408
Riverwash	Indiana 3, 10; Kentucky 2; Louisiana 4, 6; Mississippi 1, 5; Missouri 1, 8, 10, 22; North Dakota 5; Wisconsin 9.	52,480
Muck	Alabama 2; Connecticut 2; Georgia 10; Kentucky 2; Louisiana 11.	46,912
Salty marsh	Kansas 10	41,472
Wash	Missouri 21	37,248
Marsh	Florida 1, 5; Louisiana 13	9,024
Overwash	Missouri 1	7,232
Peat	Louisiana 10; Wisconsin 9	6,080
Total		5,461,239

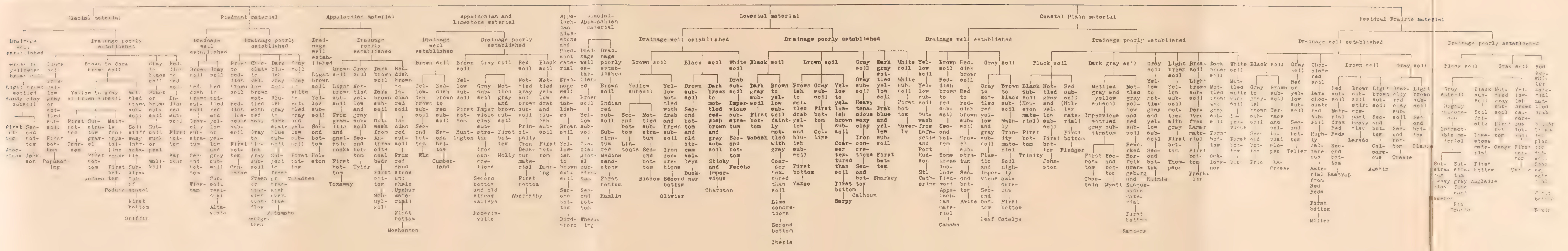
[1] For key to numbers in this column see p. 733.

Bulletin 96, Bureau of Soils, U. S. Dept. of Agr.

Fig. 7.

Revision of September, 1912

Key to the Soils of the River Flood Plains Province.



SOILS OF THE GREAT PLAINS REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

The Great Plains region as recognized in the major regional classification of soils consists of the nonglaciated part of the western prairies and plains.

Its northern half is bounded on the north and east by the Glacial and Loessial province, which marks the southern and western limits of glaciation and whose northern division follows in general the course of the Missouri River. On the east the Great Plains region is limited in Texas and Oklahoma by the Gulf Coastal Plain, and in eastern Oklahoma and Kansas and southeastern Missouri by the Ozark Uplift included within the Appalachian Mountain and Plateau and the Limestone Valley and Upland provinces. It extends south to the Rio Grande, which constitutes the international boundary, and west to the foot of the Rocky Mountains, which form the eastern boundary of the Rocky Mountain and Plateau region. Its boundary through south-central New Mexico and Texas is nearly coincident with the valley of the Pecos River, marking the eastern limit of the Arid Southwest region.

The region thus extends from the Rio Grande River nearly to the Canadian boundary, and has a maximum width from east to west of some 600 miles. It covers the greater part of eastern Montana, southwestern North Dakota, western South Dakota, Nebraska, and Kansas, eastern Wyoming, Colorado, and New Mexico, western Texas, most of Oklahoma, and parts of eastern Kansas and western Missouri. A number of isolated mountain ridges and domes, forming detached areas of the Rocky Mountain and Plateau region, are included within this region.

In the middle section of its western boundary, at the foot of the Rocky Mountains, the region reaches a height of about 6,000 feet, with an elevation of some 4,000 feet in the northern and southern sections. From this the elevation decreases to about 2,000 feet along the northern part, and to less than 1,000 feet along the southeastern and middle parts of the eastern boundary.

The surface of the Great Plains region where uneroded is level or gently sloping, but the greater part of the region has been sufficiently eroded to produce an undulating or rolling topography, and areas of excessively eroded or "bad land" topography occur. The region is traversed by occasional flat, broad stream valleys following a general easterly course, and by newer valleys of broad and shallow to deep, narrow character.

The varying conditions encountered in the character of rocks or of unconsolidated material, in topography, and in soil-forming processes have given rise to several distinct physiographic and soil provinces within the region.

The western, more elevated, and flatter areas comprise the High Plains or uneroded remnants of a former more extensive plateau surface, which are covered by unconsolidated material of Tertiary age, derived mainly from pre-Cambrian gneisses and granites of the Rocky Mountains. This has been distributed as outwash alluvial fan or foot-slope material by shifting aggrading streams. The unconsolidated fluviatile deposits have been subsequently altered to some extent by weathering and frequently modified somewhat by winds, running water, or other agencies, forming a distinct soil province designated as material of the Outwash Plains. Local areas of alluvial fan and alluvial foot-slope deposits have been included within this province.

The lighter-textured soils of the region are usually wind blown, and the soils in certain sections often consist essentially of wind-deposited material, giving rise to eolian soils or soils of the Windlaid province. They are represented in the central and eastern parts of the region by several soil series, including the Colby, Derby, and Finney soils.

Besides the areas covered by unconsolidated deposits there are extensive areas of sandstone, shale, and limestone of Cretaceous, Permian, and Carboniferous

age. Weathering of these rocks in place has given rise to wide areas of residual soils, which represent the residual province of the region.

The deposition of sediments from the waters of streams has resulted in the formation of a number of series of alluvial soils, which occupy the stream bottoms and terraces of the valleys and constitute the River Flood Plain province of soils. These are represented by the soils of the Arkansas, Lincoln, Laurel, Wade, Vale and related series.

In local depressions throughout the plains accumulations of sedimentary material occur. This has been transported by minor streams or washed from adjoining slopes and deposited in the shallow waters of temporary lakes. Such material is recognized as soils of the Lacustrine or Lake-laid province.

The more humid portions of the region are extensively utilized for the production of corn, wheat, flax, cotton, and other staples. Upon a great part of the semiarid areas yields are uncertain without irrigation. but under irrigation large areas of the valley and plains soils are valuable for the production of alfalfa, grains, and special crops, such as sugar beets, melons, etc. Extensive areas of the rougher and more arid districts are also utilized for grazing.

The following areas of the various soil provinces of the Great Plains region have been surveyed:

Soil province.	Types.	Undifferentiated.	Total series.
Residual material	14,172,001	24,959,232	39,131,233
Glacial material	350,208		350,208
Lake-laid material	69,120	39,168	108,288
Wind-laid material	18,699,584		18,699,584
Alluvial fan and filled-in valley material	22,467,584	8,640,576	31,108,160
River Flood Plain material	1,768,832	3,708,608	5,477,440
Miscellaneous		25,524,825	25,524,825
Total	57,527,329	62,872,409	120,399,738

Of the 57,527,329 acres of soil types and phases that have been differentiated, the following table shows the amount and proportion of each grade of material:

Grade.	Acres.	Per cent.	Grade.	Acres.	Per cent.
Sand	1,003,072	1.7	Silt loam	28,968,679	50.6
Fine sand	1,264,064	2.0	Clay loam	8,441,984	14.7
Sandy loam	1,758,784	3.0	Clay	1,460,608	2.5
Fine sandy loam	7,869,773	13.7			
Loam	6,760,365	11.8	Total	57,527,329	100.0

RESIDUAL MATERIAL.

The residual soils of the Great Plains region are of widespread occurrence and constitute the most extensively developed and most important province of soils in the Great Plains region. They are formed by weathering in place of sedimentary rocks, usually lying in an approximately horizontal position.

In certain parts of the region interbedded standstones and shales, often of calcareous character, predominate, in other areas sandstones or shales alone are exposed, while in others the soils are derived from an admixture of material from sandstone, limestone, and shale, or from limestone with but little or no intermingling of material from sandstone or shale rocks. Of those derived from both sandstone and shale the soils of the Morton, Boone, Bates, Spearfish, Oswego, Englewood, and Vernon series are extensively developed. The soils derived exclusively from sandstone are of limited extent, as the sandstones are generally associated with other rocks. The sandstone soils are represented by the Lancaster series. Those derived exclusively from shales are of more frequent occurrence and more extensive development, and include the soils of the Pierre, Hannibal, and Epping series. The limestone soils are still more extensive, and include as the more important representatives the soils of the Gasconade, Crawford, Dodgville, Wagoner, and Brackett series. The soils derived from the weathering in place of an admixture or a succession of

rocks, including sandstone, shales, and limestone, are widely distributed and include the soils of the Leslie, Summit, Clark, Hermosa, Kildeer, Benton, Belvedere, Sidney, and Hamilton series.

The residual soils of the region are often shallow, excessively drained, and of rough, broken topography. They include in the semiarid districts extensive areas of eroded or minutely dissected character, often developing a characteristic "bad land" type of topography, but the predominating topography of most of the soil series is gently undulating to rolling and favorable to the extensive and effective use of farm machinery. The soil areas are generally treeless or support only a stunted growth of timber, but in the southeastern sections of the region some of the soils are or were heavily timbered.

Owing to their extensive distribution, the residual soils are subject to wide variation in regional climatic influences. The middle, eastern, and southeastern areas are fairly well supplied with moisture, though summer droughts sometimes occur. In the western areas the rainfall is inadequate, and the practice of farming without irrigation is often precarious. Extensive areas have been placed under irrigation, but the water supply available for such use is limited, and a great part of the semiarid area of residual soil is capable of being used only for grazing purposes, or for the culture of drought-resistant crops through the practice of efficient moisture-conserving methods of tillage.

The residual soils predominate in the eastern and southeastern sections of the Great Plains region, the most extensive soils of agricultural importance covering parts of the Dakotas, Nebraska, Kansas, Missouri, Oklahoma, and Texas. Extensive areas of the more elevated plains in the western part of the region are also occupied by residual soils, but in such locations they are frequently interrupted or obscured by soils derived from the material of the alluvial foot-slope or stream-outwash plains, are often sparsely settled, and are of less agricultural importance except where irrigated. Under irrigation agriculture is successful.

The residual soils are devoted mainly to general farming and contribute materially to the production of corn, small grains, and live stock in the Middle Western States.

DESCRIPTION OF THE SOIL SERIES.

Bates series.—The soils of the Bates series are of dark gray color. The subsoils are yellowish and mottled red or yellowish or buff in the upper part and mottled with yellow and red in the deeper section. The series is of residual origin, and is derived from sandstone and shale rocks. The soils of this series are distinguished from those of the associated Oswego series by their more pervious subsoils, and from the Boone series by the darker color of the surface soils. They are usually well drained, treeless, and of level to undulating topography. The series is utilized mainly for the production of the staple farm crops of the region in which they occur, including corn, wheat, flax, oats, and some hay.

Area and distribution of the soils of the Bates series.

Soil name.	State or area.[1]	Acres.
Bates loam	Missouri 3, 5	92,416
silt loam	Missouri 3, 6	64,256
clay loam	Missouri 5	25,344
Total		182,016

[1] For key to numbers in this column see p. 733.

Belvidere series.—The soils are grayish yellow to brown, and are underlain by grayish-yellow subsoils. They are of residual origin, and derived from shales. Small amounts of rounded gravel derived from eroded Tertiary deposits frequently appear on the surface. A substratum of bedrock usually occurs often at shallow depth. This frequently outcrops on eroded surfaces. The members of the series are generally shallow, deficient in moisture-retaining capacity, and of too rough and broken topography to be suitable for the production of crops. They are generally utilized only for grazing.

Area and distribution of the soil of the Belvidere series.

Soil name.	State or area.[1]	Acres.
Belvidere silt loam	Kansas 10	23,040

[1] For key to number in this column see p. 733.

Benton series.—The soils of this series are of light-brown or grayish-brown to gray color, with light gray subsoils.

The series is of residual origin, and is derived from shale and limestone material. Fragments of shale and limestone occur in the soil and subsoil. A substratum of bedrock is frequently encountered at shallow depth, and occasionally outcrops along eroded surfaces. The topography is usually rough and broken, the soils occupying eroded and dissected plateau plains. The members of the series are deficient in moisture-retaining capacity, and are generally devoted to grazing. The less hilly, broken, and shallow areas are adapted to the production of forage crops in connection with stock raising.

Area and distribution of the soils of the Benton series.

Soil name.	State or area.[1]	Acres.
Benton fine sandy loam	Colorado 2	196,480
loam	do	78,784
stony loam	Kansas 10; Nebraska 7	688,896
loam adobe	Colorado 2, 3	42,880
silt loam	Colorado 3	236,288
Total		1,243,328

[1] For key to numbers in this column see p. 733.

Boone series.—The Boone series consists of light-gray soils, containing a small amount of organic matter, underlain by pale yellowish to slightly reddish yellow and often mottled, porous subsoils. A bedrock substratum is frequently encountered at shallow depth. The soils of this series are of residual origin, being derived from sandstones and shales, principally of Carboniferous age. The topography is rolling to steeply sloping, and the soils are usually timbered. This series is closely associated with the Bates series, but differs from it in containing smaller amounts of humus, with consequent lighter color, and lighter forest covering. The soils are often thin and unproductive. The principal crops are corn, oats, wheat, and hay. Melons and truck crops are grown locally.

Area and distribution of the soils of the Boone series.

Soil name.	State or area.[1]	Acres.
Boone sand	Minnesota 5; Wisconsin 3, 14	31,296
fine sand	Wisconsin 7, 9	133,312
sandy loam	Wisconsin 14	16,064
fine sandy loam	Kansas 9; Missouri 3, 5, 16; Wisconsin 5, 7, 9	62,912
stony loam	Missouri 5	10,432
silt loam	Missouri 3, 6	80,192
Total		334,208

[1] For key to numbers in this column see p. 733.

Brackett series.—The soils of the Bracket series are light gray to grayish-brown. They are generally low in organic matter content and rich in lime. The subsoils are shallow, and are usually similar in color and character to the soil material. They are underlain by a bedrock stratum. The soils of the series are of residual origin, and are derived from soft chalky limestones. They are associated in origin and mode of formation with the soils of the Crawford series, but differ from them in color, humus content, and in that

they receive less rainfall. The topography is generally rough or rolling and dissected by intermittent streams and gullies, but it is not generally so rugged as to prevent cultivation. The soils are not culivated to any extent, and are utilized mainly for grazing.

Area and distribution of the soil of the Brackett series.

Soil name.	State or area.[1]	Acres.
Brackett stony clay loam	Texas 28	391,680

[1] For key to number in this column see p. 733.

Castleton series.—The soils of the Castleton series are dark brown to reddish-brown, and vary in depth. A substratum of bedrock occurs at from 6 to about 15 inches from the surface. The series is of residual origin, having been derived from thin shaly limestone. This limestone lies in contact with the red sandstones and shales of the Permian Red Beds, and is probably the upper member of this formation. The soils occupy benchlike positions just below the Tertiary prairie, and are usually droughty on account of the shallowness of the material overlying the rock, so that their agricultural value is limited. Fair crops can be grown on these soils in seasons of more than normal rainfall.

Area and distribution of the soil of the Castleton series.

Soil name.	State or area.[1]	Acres.
Castleton silt loam	Kansas 6	2,944

[1] For key to number in this column see p. 733.

Clark series.—The Clark series includes dark-gray to dark-brown or black soils and grayish, calcareous subsoils. The soils are of residual origin and are derived from the consolidated calcareous material known as the Mortar Beds phase of the Tertiary formation. The subsoils contain large amounts of the unweathered white chalky material characteristic of the Mortar Beds. The soils produce fair yields of corn, kafir, wheat, sorghum, and other grains. Alfalfa does fairly well.

Area and distribution of the soils of the Clark series.

Soil name.	State or area.[1]	Acres.
Clark sandy loam	Kansas 6	8,320
loam	do	11,520
stony loam	Kansas 10	161,280
clay loam	Kansas 6	23,232
undifferentiated	Kansas 10	46,080
Total		250,432

[1] For key to numbers in this column see p. 733.

Cottonwood series.—The soils are of dark-brown color and of friable character. The subsoils are light gray or white in color, and are often of flourlike or ashy texture. The material consists mainly of impure gypsum and contains fragments of this material. The series is of residual origin and is derived from gypsum lentils or deposits occurring in shale and sandstone rocks. The topography is level to undulating. The members of the series are unimportant in extent and agriculture, and are utilized mainly for grazing.

Area and distribution of the soil of the Cottonwood series.

Soil name.	State or area.[1]	Acres.
Cottonwood loam	Texas 22	2,304

[1] For key to number in this column see p. 733.

Crawford series.—This series comprises residual limestone soils of the prairie regions, including dark-brown to reddish-brown surface soils and reddish-brown to red subsoils. Although derived from limestone, these soils contain only a small percentage of lime, differing materially in this respect from the soils of the Houston series which occur in the Cretaceous black prairies of the Coastal Plain. The members of the series occupy undulating or rolling areas and sometimes local areas of rough, broken topography. They are generally well drained, productive, and are adapted to general farming. Cotton, corn, wheat, and oats are the principal crops. Alfalfa, clover, and timothy are grown to some extent on the heavier members. Some of the soils, including those of stony or gravelly character, are adapted to grapes, tree fruits, small fruits, and vegetables.

Area and distribution of the soils of the Crawford series.

Soil name.	State or area.[1]	Acres.
Crawford loam	Texas 31	6,784
gravelly loam	Kansas 1	5,165
silt loam	Kansas 1, 11; Missouri 3, 10	320,039
clay loam	Texas 9	8,448
stony clay loam	Missouri 10, 16	39,872
silty clay loam	Kansas 9	7,936
clay	Kansas 4; Texas 11, 31	184,384
stony clay	Texas 2, 11, 26, 28, 31	310,144
Total		882,772

[1] For key to numbers in this column see p. 733.

Dodgeville series.—The soils of the Dodgeville series are dark brown to almost black in color and are essentially silty in texture. The subsoils are light reddish brown, buff, or brown. The members of the series are of residual origin. They are derived from the weathering of limestone with a slight admixture of loessial material. It is difficult, however, to detect the presence of the loess on account of its extreme thinness where present, and because of the fact that the texture is essentially the same as that of the residual material from limestone. The topography is rolling to somewhat hilly. The soil is thin in places, the underlying rock being encountered at a depth of 3 feet or slightly less, though in general the soil covering is much thicker. These soils are well adapted to wheat, oats, corn, hay, and general farm crops.

Area and distribution of the soil of the Dodgeville series.

Soil name.	State or area.[1]	Acres.
Dodgeville silt loam	Wisconsin 5	56,128

[1] For key to number in this column see p. 733.

Eldorado series.—The soils are dark brown and the subsoils yellow to gray with red mottlings. The soil and subsoil material frequently contains chert fragments. The series is of residual origin, derived from limestone. The topography is rolling, and drainage is well established. The soils of the series are adapted to general farm crops, and are utilized mainly for the production of wheat, corn, and grass crops.

Area and distribution of the soil of the Eldorado series.

Soil name.	State or area.[1]	Acres.
Eldorado stony loam	Missouri 5	28,224

[1] For key to number in this column see p. 733.

Englewood series.—The soils are of brown to reddish-brown color. The subsoils are usually reddish brown, but sometimes brown. The series is mainly of residual origin and is derived from shale and sandstone material of the Permian Red Beds. The soils contain an admixture of material derived from unconsolidated Tertiary deposits, probably mainly from crystalline rocks. The subsoils are entirely residual. Owing to erosion, the soils are often thin and the subsoils exposed. The series occupy gently rolling to undulating areas, and drainage is well established. The soils are especially adapted to corn, kafir corn, and sorghum, and other grain and hay crops are grown. Good yields are secured in favorable seasons.

Area and distribution of the soils of the Englewood series.

Soil name.	State or area.[1]	Acres.
Englewood sandy loam	Kansas 6	2,688
fine sandy loam	Kansas 10	64,512
loam	Kansas 6	7,232
silt loam	Kansas 10	145,152
Total		219,584

[1] For key to numbers in this column see p. 733.

Epping series.—The soils of the Epping series are of white or light-gray to buff color, and are underlain by subsoils similar in color and character to the soil material. They are of residual origin and are derived from the weathering in place of shales and indurated clays. Drainage conditions are subject to wide variation. Normally the soils are well drained and are subject to excessive erosion. They occupy undulating or dissected plains to sloping or comparatively level flats. Some of the lower lying areas, however, occur as local flats or terraces of erosion in stream valleys, and are subject to the accumulation of seepage or drainage waters, being without surface drainage or subdrainage. The soils are deficient in organic matter and are rather difficult to maintain in a favorable condition of structure when first cultivated. The rougher or unirrigated areas are utilized mainly for grazing. Where irrigated, alfalfa, wheat, barley, and potatoes constitute the principal products.

Area and distribution of the soil of the Epping series.

Soil name.	State or area.[1]	Acres.
Epping silt loam	Nebraska 7	313,344

[1] For key to number in this column see p. 733.

Fort Collins series.—This series consists of dark-brown or reddish-brown to almost black soils from 4 to 12 inches deep, underlain by a layer of heavy loam from 1 to 4 feet in thickness, beneath which the subsoil grades into a light loam similar to the surface soil and extending to a depth of 6 feet or more. The loam and heavier members of the series become sticky when wet, and bake badly, often breaking into rough, cubical blocks upon exposure after puddling. In general the surface is level, though in places it is slightly rolling or undulating, and sometimes pitted by erosion and cut by small intermittent streams. This is for the most part a residual series formed by the weathering

in place of clayey or shaly sandstones and sandy shales of the Pierre, Laramie, and Fort Union formations of Cretaceous age. The soil is adapted to wheat, oats, barley, alfalfa, sugar beets, potatoes, and apples.

Area and distribution of the soil of the Fort Collins series.

Soil name.	State or area.[1]	Acres.
Fort Collins loam	Colorado 2	14,144

[1] For key to number in this column see p. 733.

Gasconade series.—The Gasconade series includes dark-gray to black soils with mottled brown, yellow, and red plastic and usually heavy clay subsoils. These soils are of residual origin and are underlain by a stratum of chert-free limestone from which they have been derived. The surface is undulating to gently sloping. In general the drainage is good, but there are a few places where springs keep the soil in a permanent soggy condition. A great part of the series was originally prairie land. Post oak, wild plum, locust, elm, and hawthorn constitute the natural growth over some areas. These soils are productive, and are well suited to corn, clover, timothy, and wheat.

Area and distribution of the soils of the Gasconade series.

Soil name.	State or area.[1]	Acres.
Gasconade silt loam	Arkansas 2; Missouri 7	16,320
silty clay loam	Missouri 11	3,648
Total		19,968

[1] For key to numbers in this column see p. 733.

Gerald series.—The surface soils are of gray or grayish-brown to light-brown color and silty texture. The subsoils consist of light-brown or yellowish-brown silty clay loam, which grades into a dingy or snuff-brown plastic heavy clay deeper subsoil, frequently mottled with gray. A substratum of sandstone often occurs at a depth of about 36 to 48 inches. Iron concretions are of common occurrence in the soil and subsoil. The topography varies from flat to strongly rolling, and is not badly dissected or broken. Surface drainage is good over the predominant rolling country, but underdrainage is poor on account of the imperviousness of the heavy clay subsoil. The flat areas represent poorly drained late soils. The series is typically developed through a broad section of the northern Ozark Plateau region. In its mode of formation and the character of its parent material the series is probably similar to the Oswego series, which it closely resembles, except that its color is lighter. A large part of the Gerald series exists under prairie conditions. A great part of the rolling areas supports a forest of oak of rather stunted growth and some hickory. The soils are utilized principally for the production of wheat, corn, and oats, and to some extent for bluegrass and cowpeas. Their agricultural value is only fair.

Area and distribution of the soil of the Gerald series.

Soil name.	State or area.[1]	Acres.
Gerald silt loam	Missouri 8	80,000

[1] For key to number in this column see p. 733.

Hamilton series.[1]—The soils of the Hamilton series are of brown color and usually of compact structure, becoming sticky when wet and baking and check-

[1] Encountered only in reconnoissance work and the several types have not been differentiated.

ing upon drying. The subsoils consist of yellowish gray, with mottlings of white, calcareous, and generally porous material. The lime content is sometimes excessive, giving rise to a light-gray or white color. The series is mainly of residual origin, but the surface material is made up in part of gravels, sands, and finer material, derived from soft, consolidated Tertiary deposits of calcareous character and subsequently modified or shifted by winds or by alluvial agencies. The remainder of the soil and subsoil material is residual from shales. A substratum of shale or of calcareous cemented sands and gravels of the Mortar Beds of the Tertiary deposits often occurs. The topography varies from gently rolling to rolling or broken. The soils of this series are not extensively utilized and are best adapted to grazing and stock raising, with local cultivation of milo, kafir, sorghum, etc., where suitable areas occur.

Area and distribution of the soil of the Hamilton series.

Soil name.	State or area.[1]	Acres.
Hamilton soils, undifferentiated	Kansas 10	237,312

[1] For key to number in this column see p. 733.

Hannibal series.—The soils of this series are gray to brown in color and overlie yellowish or greenish yellow tenacious subsoils. They are of residual origin and are derived from soft, easily weathered shales. They sometimes contain fragments of the shale and of the sandstone which immediately overlies it. The soils occupy slopes or benches and sometimes gullied or eroded steep hillsides. Low-lying areas are poorly drained, but otherwise drainage is fairly well established. Where they can be cultivated they are moderately productive, giving fair yields of wheat and corn.

Area and distribution of the soil of the Hannibal series.

Soil name.	State or area.[1]	Acres.
Hannibal silt loam	Missouri 5, 13	14,848

[1] For key to numbers in this column see p. 733.

Hermosa series.—The soils of the Hermosa series are dark brown. The subsoils are brown and are calcareous. The soils occur upon plateau plains, usually of level to gently sloping surface, but of rough, hilly character where eroded by streams. The series is of residual origin, and derived from soft calcareous sandstones and conglomerates of the slightly consolidated calcareous deposits of Tertiary material of the Great Plains region. The members of the series are usually associated with the soils of the Rosebud series. Under favorable climatic and topographic conditions they are productive and adapted to general farm crops, including corn, small grains, and potatoes.

Area and distribution of the soil of the Hermosa series.

Soil name.	State or area.[1]	Acres.
Hermosa loam	South Dakota 3	119,808

[1] For key to number in this column see p. 733.

Kildeer series.—The soils of the Kildeer series are dark gray to dark brown, while the subsoils are of light-gray to light-brown color. The soil and subsoil material is calcareous and of residual origin. It is derived from limestones and calcareous shales. The soils of this series occur upon sloping or comparatively level plateau plains and on eroded remnants of such areas or elevated eroded buttes. The rougher areas are broken by rock outcrop and are not

suited to extensive cultivation. Where favored by topography and climate the soils of good depth are adapted to corn, wheat, oats, barley, and other grains.

Area and distribution of the soil of the Kildeer series.

Soil name.	State or area.[1]	Acres.
Kildeer loam	North Dakota 10	46,080

[1] For key to number in this column see p. 733.

Kirkland series.—The Kirkland series consists of brown surface soils with brown or yellowish-brown compact subsoils. It is closely associated with the Vernon series, and is a soil of residual origin derived from the shales and sandstones of the Permian Red Beds. It differs from the Vernon series in possessing darker colored soils and subsoils. The decided red color of the rocks giving rise to the Vernon soils is here replaced by a more dingy or dark-reddish brown or grayish-red color, with mottling in some places. The texture of the rock is also finer where this series is developed. It is a clayey shale, sometimes calcareous or interbedded with limestone. The series occupies regions of gently rolling topography. The soils are utilized mainly for grazing or for the production of cotton, corn, forage crops, and grains. The rainfall is so uncertain that they are best adapted to drought-resisting forage crops.

Area and distribution of the soils of the Kirkland series.

Soil name.	State or area.[1]	Acres.
Kirkland silty clay loam	Texas 22	52,992
clay	Kansas 6	40,064
Total		93,056

[1] For key to numbers in this column see p. 733.

Lancaster series.—The soils are dark brown and the subsoils are yellow to gray. Both soil and subsoil are of open, porous structure, and the soil is easily cultivated. In places a layer of finer material occurs about 2 feet below the surface in the subsoil. The topography is rolling to hilly and surface and underdrainage are both good. The series is derived from sandstone and is residual. The soils of the series are rather low in productive capacity. Under favorable conditions of topography and climate the lighter members are well adapted to truck crops.

Area and distribution of the soil of the Lancaster series.

Soil name.	State or area.[1]	Acres.
Lancaster fine sandy loam	Nebraska 3	2,368

[1] For key to number in this column see p. 733.

Leslie series.—The soils of the Leslie series are black and are underlain by dark-gray or mottled, compact, tough clay subsoils. The depth of the soil and subsoil material varies from a few inches to several feet. It is underlain by a stratum of alternating beds of limestone and black fissile shale, from which the series is derived as a residual product. Fragments of limestone and shale are present to some extent in the soils and subsoils. The topography varies from steep to rolling. Under favorable topographic conditions the soils are particularly adapted to corn, wheat, and oats, but are not extensively utilized, owing to the steep slopes and heavy forest cover

Area and distribution of the soil of the Leslie series.

Soil name.	State or area.[1]	Acres.
Leslie clay	Missouri 2	1,216

[1] For key to number in this column see p. 733.

Morton series.—The soils are brown in color and contain a high percentage of organic matter. The subsoils are light brown to gray. These soils, especially the subsoils, are usually rich in lime. Gravel or rock fragments rarely occur. The series occupies undulating to rolling and sometimes rough hilly prairies. It consists of residual soils derived principally from the sandstones and shales of the Laramie formation. The series is extensively devoted to grazing and to dry farming to grains. Wheat, barley, and flax are the principal products.

Area and distribution of the soils of the Morton series.

Soil name.	State or area.[1]	Acres.
Morton fine sand	North Dakota 6, 7	4,352
fine sandy loam	North Dakota 6, 7; South Dakota 3	2,548,672
loam	North Dakota 7	163,456
stony loam	North Dakota 6, 7	48,128
silt loam	North Dakota 6	104,576
clay loam	North Dakota 6, 7	17,024
clay	North Dakota 7; South Dakota 3	9,920
gumbo	North Dakota 7; South Dakota 3	404,736
undifferentiated	North Dakota 10; South Dakota 3	9,873,408
Total		13,174,272

[1] For key to numbers in this column see p. 733.

Oswego series.—The soils of the Oswego series are light gray to dark gray. The subsoils are drab to yellow and are compact and impervious. The series is of residual origin and derived from interbedded sandstone and shale, which sometimes occur as a bedrock substratum at comparatively shallow depth. The topography is gently rolling or rolling and the soils are favored by good surface drainage, but subdrainage is sometimes deficient. They are generally less productive than the associated soils of the Crawford series, but constitute important staple crop soils. Wheat, corn, oats, flax, rye, and potatoes are the principal products.

Area and distribution of the soils of the Oswego series.

Soil name.	State or area.[1]	Acres.
Oswego sandy loam	Kansas 10	82,944
fine sandy loam	Kansas 1, 4	25,293
silt loam	Kansas 1, 4, 7, 9; Missouri 3, 5, 6	783,616
silty clay loam	Kansas 9	18,688
Total		910,541

[1] For key to numbers in this column see p. 733.

Pierre series.—The soils of the Pierre series are light brown to dark brown, the immediate surface often being light gray. They are usually compact and refractory and the subsoil frequently contains fragments of disintegrated clay concretions. The subsoils are brown and compact and grade into a substratum of partially weathered shale. This bedrock substratum does not usually occur at less than 6 feet. The surface is generally irregular, being dissected or eroded and marked by hills and ridges. Drainage is generally good, but in local, poorly drained depressions the subdrainage is deficient. The series is of residual origin and is derived from shales. The types frequently contain rather excessive amounts of alkali salts.

Area and distribution of the soils of the Pierre series.

Soil name.	State or area.[1]	Acres.
Pierre clay loam	South Dakota 1	24,192
clay	South Dakota 1	41,088
undifferentiated	Nebraska 7; South Dakota 3	10,795,776
Total		10,861,056

[1] For key to numbers in this column see p. 733.

Sidney series.—The Sidney series consists of brown surface soils with light-gray to white, calcareous, floury silty clay subsoils. The soils of this series are distinguished from those of the Rosebud series, with which they are associated, by the brown color of the soils and the white color and floury texture of the subsoils. Water-worn gravel occurs in both soil and subsoil of all the types. These soils cover a part of the High Plains and the topography ranges from gently undulating to very hilly and broken. The soils are residual and are derived from cemented calcareous conglomerate with clay and silt material of the Tertiary deposits. The more loamy types are excellent soils for general farming.

Area and distribution of the soils of the Sidney series.

Soil name.	State or area.[1]	Acres.
Sidney sandy loam	Nebraska 7	292,608
gravelly sandy loam	do	343,296
loam	do	705,024
silt loam	do	1,405,440
Total		2,746,368

[1] For key to number in this column see p. 733.

Spearfish series.—The soils of the Spearfish series are chocolate brown to red, and sometimes carry an amount of organic matter sufficient to impart a dark-brown color to the immediate surface. The subsoils are reddish-brown to red. Fragments of gypsum usually occur in both soil and subsoil. The subsoils are underlain by a stratum of gypsum or gypsum-bearing rocks, often occurring at shallow depth. The series is of residual origin and is derived from gypsum-bearing shales and sandstones. The topography is level or gently rolling to rough. Owing to its shallow character and lack of irrigation possibilities, a large part of the series is not developed to agriculture. Where of sufficient depth, and particularly where irrigated, the soils are adapted to orchard and truck crops and to alfalfa.

Area and distribution of the soil of the Spearfish series.

Soil name.	State or area.[1]	Acres.
Spearfish loam	South Dakota 3	200,448

[1] For key to number in this column see p. 733.

Summit series.—The soils are dark gray to black, with mottled yellow and gray subsoils. The soils occupy smooth and nearly flat to sharply rolling prairies. The series is of residual origin and is derived from calcareous shales associated with thin interbedded layers of limestone. The soils contain a large amount of organic matter. Drainage is usually well established. The members of this series are of darker color and of higher agricultural value than the soils of the Bates and Oswego series, with which they are associated. They are known locally as "black limestone lands." They are well adapted to the staple farm products of the regions in which they occur. Corn, wheat, oats, timothy, clover, and alfalfa are the principal products.

Area and distribution of the soils of the Summit series.

Soil name.	State or area.[1]	Acres.
Summit silt loam	Missouri 3, 10	228,480
clay loam	Missouri 10	20,224
silty clay loam	Kansas 9; Missouri 10	146,048
clay	Missouri 3	14,976
undifferentiated	Kansas 10; Nebraska 7	4,006,656
Total		4,416,384

[1] For key to numbers in this column see p. 733.

Vernon series.—The soils are reddish brown to red. The subsoils are usually red, but sometimes reddish brown or brown in the upper part. This series occurs extensively in the prairie regions of northern Texas, Oklahoma, and southern Kansas. The soils are residual, and are derived from sandstones and shales, mainly of the Permian Red Beds. The topography varies from gently rolling to dissected and excessively eroded. The lighter members of the series are usually wind blown. The soils are generally well drained, productive, and adapted to general farm crops. Cotton, wheat, oats, corn, and forage crops, including kafir corn, maize, and sorghum, are the principal products. Under suitable moisture conditions some of the lighter types are adapted to melons, truck crops, and certain tree fruits.

Area and distribution of the soils of the Vernon series.

Soil name.	State or area.[1]	Acres.
Vernon sand	Oklahoma 1; Texas 30	68,224
fine sand	Oklahoma 1	44,928
sandy loam	Oklahoma 1; Texas 30	40,576
fine sandy loam	Oklahoma 1; Texas 22, 30	526,720
very fine sandy loam	Kansas 6	7,680
loam	Texas 22	732,672
silt loam	Kansas 10; Oklahoma 1; Texas 30	768,768
clay	Oklahoma 1; Texas 30	31,808
Total		2,221,376

[1] For key to numbers in this column see p. 733.

Wagoner series.—The soils of the Wagoner series are gray to light brown. They are underlain by yellow to gray subsoils, mottled with red. The subsoils are of heavy texture, but of granular, friable structure. Chert fragments occur in the soil and subsoil of the stony members. The series is of residual origin and derived from limestone material. The topography is rolling and drainage is well established. The timber growth consists of black oak, post oak, and hickory. The soils are adapted to general farm products, and particularly to grass crops. The stony members are suited to the cultivation of fruits.

Area and distribution of the soil of the Wagoner series.

Soil name.	State or area.[1]	Acres.
Wagoner stony silt loam	Missouri 5	41,984

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The soils of the sand group included within the residual province of the Great Plains region are of loose, porous, and usually incoherent structure. They are widely distributed, although their total area is not extensive. Thus far but two soil types have been mapped.

The soils are frequently shallow, and are sometimes eroded. Where developed as prairies they are subject to drifting and their surface is usually hummocky. They are deficient in moisture-retaining capacity in time of drought, and are not extensively utilized except for pasture. Wheat, corn, oats, and hay are the principal crops in the north, but yields are generally low. In the southern areas cotton, kafir, and sorghum are the main products, the later crops being more resistant to the pronounced conditions of drought prevailing during the summer in these areas.

The soils of this group are not adapted to general farm crops, and where subject to wind action are poorly adapted to agriculture unless protected by windbreaks. Under favorable conditions of moisture and protection from winds they are best adapted to early truck crops and melons and to peaches under intensive cultivation. Apples are successfully grown locally to a limited extent.

Boone sand.—The soil consists of a fine to medium sand from 6 to 10 inches deep. The subsoil is a fine to medium sand of mottled brown, yellow, and white color. A bedrock substratum occurs at a depth of 2 to 6 feet or more. The type is of residual origin and is derived from sandstone, but includes some colluvial talus material. It has suffered somewhat from erosion and surface washing. It occurs inextensively and is but little utilized. The soil is loose and porous and is deficient in moisture-retaining capacity. It is devoted mainly to corn, wheat, oats, and hay, with low yields. It is better adapted to fruit and early truck crops.

Vernon sand.—The surface soil is a gray to reddish brown loose, incoherent medium sand, and is underlain by a reddish-yellow slightly more compact sand to a depth of 3 feet or more. The soil is of residual origin and derived from sandstone, but includes some wind-laid material from stream channels. The type is wind-blown and its surface is hummocky to dunelike. The soil is well drained. Kafir, sorghum, and cotton are the principal crops, but much of the type is not suitable for agriculture, drifting badly when cleared of native vegetation. Apples, peaches, and melons do well where moisture conditions are favorable and protection from winds is afforded.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Vernon sand	Oklahoma 1; Texas 30	68,224
Boone sand	Minnesota 5; Wisconsin 3, 14	31,296
Total		99,520

[1] For key to numbers in this column see p. 733.

Fine Sand Group.

The soils of the fine sand group occupy somewhat elevated positions, and the topography is usually sloping. The soils are loose and porous, and are excessively drained. They are often underlain by bedrock at shallow depths and are deficient in moisture-retaining capacity during periods of restricted rainfall. They are not extensively cultivated and are devoted mainly to grazing. When cultivated the soil is subject to erosion, and to wind drifting where not protected by wind-breaks or by natural vegetation. Some corn, cotton, and peaches are grown.

The members of the fine sand group are not adapted to general farming purposes. They are, however, easily cultivated and are warm, early soils which favor the early spring growth of native grasses in the Northern States where such grasses are of value in the grazing industry, but fail with the early advance of summer drought. Where protected from winds and favored by conditions of moisture supply, the soils are well adapted to early potatoes, early truck crops, and peaches.

The soils of the group require only a light farming equipment, but owing to the light rainfall in the areas in which they occur their extensive cultivation is somewhat hazardous. In their utilization and adaptation to agriculture they do not depart greatly from the soils of the sand group of this province.

Boone fine sand.—The soil to an average depth of about 10 inches is a brown to light-brown, rather loose, incoherent fine sand. The subsoil is a light-brown to yellow incoherent fine sand generally 3 feet or more in depth. In places the

subsoil passes at about 2 feet into the partially weathered sandstone from which the type is derived. The topography varies from gently undulating to quite rolling and steep, so that the use of modern farm machinery is sometimes prohibited. Drainage is good to excessive, and some erosion occurs on steep hillsides. Over small areas small dunes have been formed by wind action. The original timber growth was principally bur oak and other scrub oaks. The agricultural value is low. Such crops as corn and rye are generally grown with only moderate profit. Pastures are scanty.

Morton fine sand.—The type consists of from 5 to 10 inches of a light-brown, very fine silty sand, underlain by a fine silty sand of lighter color. The soil is loose and incoherent and contains organic matter in varying amounts. The subsoil at a depth of 3 feet or less passes into a partly altered sandstone substratum. It is a residual soil formed from fine-grained sandstone with subsequent removal by washing of the finer materials. It occupies the flat tops and in places the slopes of a few hills or buttes. It has a low agricultural value for general farm crops, owing to its inability to retain moisture, and is used chiefly for grazing. Under favorable moisture conditions and cultural methods it is adapted to potatoes and truck crops.

Vernon fine sand.—The soil is a gray to brown loose fine sand from 4 to 6 inches deep, and is underlain to depths varying from 2 to 3 feet by a yellowish or salmon-colored fine sand. Below this is a sandy porous clay which grades into disintegrated sandstone. The type occupies slopes and crests of ridges and has good drainage. It is residual in mode of formation and derived from fine-grained red sandstone. The native tree growth consists of scrubby black jack oaks. The soil is of low agricultural value. Some cotton, corn, and peaches are grown. Cowpeas should be grown as a means of improving the soil, and it should be protected by cover crops during the winter.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Boone fine sand	Wisconsin 7, 9	133,312
Vernon fine sand	Oklahoma 1	44,928
Morton fine sand	North Dakota 6, 7	4,352
Total		182,592

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

The soils of the sandy loam group are widely distributed and are included in several important soil series. They usually occupy areas of undulating or rolling topography which favors cultivation and the use of farm machinery, although some of the members of the group are hilly and broken. Drainage is well established.

The soils are of friable and porous structure and readily absorb rain water. Thep are easily cultivated and maintained in a favorable condition of tilth by the use of moderately light farming equipment. The subsoils are prevailingly of heavier texture and more compact structure than the surface material, and serve to check excessive subdrainage and render the group as a whole retentive of moisture. The soils are generally much less subject to erosion and wind drifting than those of lighter texture in the same series. Owing to their heavier texture and the character of underlying material, these soils are much superior to the groups of lighter textured soils in this province for general farming purposes. Crops are, however, often subject to injury from deficient moisture owing to the light rainfall over a large part of the region in which the soils occur.

Corn, wheat, kafir, and sorghum are the principal products. Oats and alfalfa are grown in certain areas, and cotton is grown in the Southern States. Under favorable climatic conditions the soils are also suited to potatoes, melons, and truck crops, and in many cases the soils are better adapted to such uses than to general farm crops, owing to greater possibilities in retention of moisture under a system of intertillage. In many districts of light rainfall the sandy loams, where accompanied by subsoils of high water-holding capacity, are superior for general farming purposes to the soil types of heavier texture during

periods of drought, owing to the more porous character of the immediate surface, which when dry tends to form a natural mulch.

Boone sandy loam.—The soil is a light-brown or grayish-brown medium sandy loam and extends to a depth of about 10 inches. The subsoil is a yellowish or reddish-yellow heavier sandy loam. Practically no stone or gravel is present in the soil section. In general the topography is rolling to hilly, though some areas on the tops of drainage divides are nearly level. Drainage is usually good. The type is derived from weathering of the sandstone country rock. Where the soil is well manured its agricultural value is fair for corn, oats, and potatoes.

Clark sandy loam.—The soil is a dark-gray to dark-brown or nearly black sandy loam, 8 to 12 inches in depth, and underlain by a gray sandy clay or loam which contains loose, chalky, calcareous material and concretions and extends to several feet in depth. The topography of the type is gently rolling to undulating, and surface drainage is good. In origin the soil is residual from weathering of the consolidated calcareous material of the Mortar Beds, in places mixed with unconsolidated sandy and gravelly material of the Tertiary formation, and modified more or less by wind action. Fair yields of corn, kafir, and sorghum are secured.

Englewood sandy loam.—The surface soil is a brown or dark-brown, rather light-textured sandy loam, varying in depth from 8 to 15 inches and containing sand and fine gravel, though not enough to cause the soil to be porous or leachy. The subsoil is a sandy loam or sandy clay which varies somewhat in color, being quite reddish where the underlying Red Beds are near the surface, or grayish where they are covered with several feet of the unconsolidated material. The topography is gently rolling to undulating. The type is derived from two geological formations, the soil resulting from the weathering of the unconsolidated Tertiary material, while the subsoil is of residual origin and derived from the shales and sandstones of the Permian Red Beds. Drainage is good. Fair yields of corn, kafir, and sorghum are secured, with lighter yields of wheat and alfalfa. Truck crops do well.

Oswego sandy loam.—The soil is light-gray to grayish-brown and from 10 to 15 inches deep. The subsoil is quite similar to the soil, but has a slightly heavier texture and lighter color. The type is of residual origin and is derived mainly from sandstone. Its topography ranges from comparatively level or gently rolling to rough. It is rather deficient in moisture-retaining capacity, but in favorable seasons produces fair crops of wheat, corn, kafir, sorghum, and potatoes. With a favorable moisture supply it is adapted to melons, truck crops, and other intertilled crops.

Sidney sandy loam.—The soil is brown to dark reddish brown, and has an average depth of about 16 inches. It is of slightly adhesive character. The upper subsoil is lighter in color and somewhat heavier in texture than the soil. The deeper subsoil is light gray or white, and calcareous. The type is of residual origin and is derived from soft, partially consolidated calcareous gravel, sand, silt, and clay formations of the Mortar Beds of Tertiary deposits, subsequently modified to some extent by winds. The topography varies from nearly level plains to hilly with dunelike undulations. The type is retentive of moisture, the surface material forming a natural mulch during dry periods. It is well adapted to corn and forage crops, and, where sheltered from winds, to small grains.

Vernon sandy loam.—The soil is a dark-red to reddish-brown sandy loam from 12 to 30 inches deep, and is mellow, friable, and easily worked. The subsoil to a depth of 36 inches is heavier in texture and varies in color from red to brown. The soil is of residual origin and derived from sandstone and shale material, but includes considerable wind-blown material. It is generally well drained and usually retentive of moisture. The topography is sloping or undulating. Corn, wheat, kafir, oats, and cotton are the principal crops on this soil type, and it is well adapted to potatoes, melons, truck crops, and alfalfa.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Sidney sandy loam	Nebraska 7	292,608
Oswego sandy loam	Kansas 10	82,944
Vernon sandy loam	Oklahoma 1; Texas 30	40,576
Boone sandy loam	Wisconsin 14	16,064
Clark sandy loam	Kansas 6	8,320
Englewood sandy loam	do	2,688
Total		443,200

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam phase of the sandy loam group has been encountered only under one soil series.

The topography is prevailingly rough and broken and is not favorable to the extensive or economical use of farm machinery. Owing to the gravel content, which renders the soil more porous, and to the porous, open structure of the upper subsoil, the type is deficient in moisture-retaining capacity and departs widely from the sandy loams in relation to agriculture.

But little attempt has been made to use this soil for other than grazing purposes, and only small areas occur which are capable of being profitably cultivated without irrigation.

Sidney gravelly sandy loam.—The soil is brown and contains varying amounts of gravel. The subsoil is lighter in color than the soil, but similar in texture. The deeper subsoil is of gray to white color and of silty or flourlike texture. The surface is usually rough or broken and dissected by streams. The type is of residual origin and is derived from soft, partially consolidated, calcareous conglomerates, and sand, clay, and silt deposits of the Tertiary age. It is prevailingly of too rough, hilly character, and too deficient in moisture-retaining capacity to be well adapted to cultivation. It is usually devoted to grazing.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Sidney gravelly sandy loam	Nebraska 7	343,296

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The soils of the fine sandy loam group are of extensive occurrence in this province. They have been recognized under a number of important soil series, ranging in distribution from the more northern to the southern portions of the Great Plains region. They are thus subject to a wide range in climatic conditions and vary in topography and in character of underlying material, with resulting influence upon drainage, moisture-retaining properties, and adaptation to crops.

The prevailing topography is undulating or rolling, but some of the members of the group are frequently hilly and some are rough, broken, and eroded or dissected. Drainage is usually well established and sometimes excessive. Underlying bedrock is encountered in places at shallow depths, but except in the areas of rough topography it does not usually approach the surface so closely as to interfere with cultivation or with root development of the staple crops of the region. The subsoils of some members of the group are compact and of heavier texture than the surface soil and their moisture-holding capacity is high. In other members of the group the subsoils are porous and leachy and not adapted to the conservation of moisture during periods of drought.

In the more sparsely settled and in rough and hilly districts the fine sandy loams are utilized extensively for grazing purposes. In the northern States the cultivated areas are devoted mainly to wheat, oats, potatoes, and flax. In the middle States of the Great Plains Region they are devoted principally to

corn, oats, potatoes, small grains, and the more drought-resistant crops, such as kafir, milo, sorghum, etc., while in the southern part of the district covered by the group cotton is grown to a limited extent.

The soil is friable and easily cultivated. The general type of agriculture practiced calls for an equipment somewhat lighter than that required on the heavier soil groups of the same series. Although typically finer and more retentive of moisture than the sandy loams, the fine sandy loams within this province, owing to their underlying material, average somewhat lower in water-holding capacity and resistance to drought. Where underlain by subsoils of greater water-holding power they vary but little from the sandy loam group in adaptation to crops and are well adapted to general farming, except in districts of insufficient rainfall. Where underlain by porous subsoils they are better adapted to intertilled drought-resistant crops, such as the sorghums, broom corn, milo, kafir, etc. Early melons and truck crops may be grown for home use or upon a commercial basis in areas favored by market and transportation conditions. In the western arid districts irrigation is usually essential to trucking and general farming. Under irrigation some of the members of the group produce melons, sugar beets, potatoes, and alfalfa and are well adapted to such crops.

Benton fine sandy loam.—This type consists of from 2 to 4 feet of a light-brown to dark-brown friable fine sandy loam, underlain by heavy fine sandy loam or loam carrying a stratum of compact and slightly heavier material.

The type occurs as extensive areas of rough and hilly to gently undulating, elevated plains, cut by deep, narrow valleys formed by intermittent streams. Local swampy depressions or closed drainage basins frequently occur. The soil is formed largely of residual material derived from underlying shales, shaly sandstone, and sandstone. The type is sometimes gravelly, generally well drained, and free from alkali except in local depressions. Under irrigation it is adapted to grains, alfalfa, potatoes, and sugar beets.

Boone fine sandy loam.—The soil to about 8 to 12 inches is a gray, loose-structured fine sandy loam, and this is underlain by a buff or yellowish-gray clay loam or sandy clay. The deeper subsoil is usually mottled with red. A bedrock substratum occurs at 10 to 30 inches. Mica flakes are present in both soil and subsoil. The type is residual and is derived from sandstones and sandy shales. The type is generally confined to abrupt slopes and its topography is rough. It is well drained. It was originally timbered, but a great part of it is now cultivated. The humus content is low and the addition of organic matter will greatly benefit the soil. It is better suited to truck crops than to general farming, although fair yields of corn, wheat, and oats are secured.

Englewood fine sandy loam.—The soil to an average depth of 16 inches is a light reddish brown fine sandy loam. The subsoil is similar in texture, but its color is lighter and more reddish. The soil is loose and incoherent. The topography is for the most part rolling and in some places the hills are dune shaped. The type is of residual origin and derived from shale and sandstone material of the Permian Red Beds, with an admixture in the surface material of sand blown in from other formations. It is better adapted to corn and the sorghums than to small grains. Melons and truck crops would do well.

Lancaster fine sandy loam.—The soil is composed of medium to fine sand, with a slight admixture of silt. It is open and porous and extends to an average depth of about 12 inches. The subsoil is composed of medium to fine sand or sandy loam of yellow to gray color. At about 25 inches a stratum of rather heavy silty material, about 5 inches in thickness, is sometimes encountered. The type has a rolling topography. It is of residual origin and derived largely from sandstone. It is not a good type for general farming. It is probably best adapted to early vegetables.

Morton fine sandy loam.—The type consists of 10 to 18 inches of light-brown, friable fine sandy loam, underlain by a subsoil which becomes slightly lighter brown or gray and heavier with depth. A bedrock substratum is sometimes encountered at a depth of 3 feet or less. The type has a moderately rolling topography. Drainage is thorough and even excessive in the rough areas. The soil is residual and formed by the weathering of fine-grained sandstone, usually of the Laramie formation, which underlies the subsoil at depths varying from 2 to 20 feet. The soil is productive, but is largely used for grazing. Under cultivation it produces good crops of flax, oats, and potatoes, and fair yields of wheat. Early-maturing corn should do well and the texture of the soil is favorable for trucking.

Oswego fine sandy loam.—The soil is a yellowish-brown or gray, heavy, friable fine sandy loam, 12 inches deep. The subsoil is of similar material, but of lighter yellowish color and sometimes heavier texture. The deeper subsoil usually contains rock fragments. This is an upland soil and occupies low, rounded knobs and ridges. Its surface is rolling. Drainage is well developed. The type is residual and the soil is derived from sandstone and arenaceous shale, which occur in places a few feet beneath the surface. Corn and oats are the principal crops, the former yielding from 20 to 30 bushels and the latter about 25 bushels per acre. Very little wheat is grown on this soil, as it is likely to winterkill. The soil is best adapted to fruit and truck crops and to corn, broom corn, and potatoes.

Vernon fine sandy loam.—The soil is a brownish-red, friable, fine to very fine sandy loam from 12 to 22 inches deep, often containing a high percentage of silt. The subsoil is similar to the soil in texture and structure, but it is lighter in color in the lower depths. At from four to six feet the material is generally a yellowish-red fine sand. The soil occupies bluffs along rivers. The surface is level to slightly rolling, and drainage is good. The type is of residual origin and derived from shales and sandstones, but the surface material locally includes wind-blown river sand. The soil is used principally for pasturage, but it is adapted to wheat, corn, oats, cotton, and other farm crops, and to fruits and truck crops.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Morton fine sandy loam	North Dakota 6, 7; South Dakota 3	2,548,672
Vernon fine sandy loam	Oklahoma 1; Texas 22, 30	526,720
Benton fine sandy loam	Colorado 2	196,480
Englewood fine sandy loam	Kansas 10	64,512
Boone fine sandy loam	Kansas 9; Missouri 3, 5, 16; Wisconsin 5, 7, 9	62,912
Oswego fine sandy loam	Kansas 1, 4	25,293
Lancaster fine sandy loam	Nebraska 3	2,368
Total		3,426,957

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

But one soil of very fine sandy loam texture has been recognized in this province and this type is confined to the southern part of the Great Plains region.

The topography is rolling and sometimes hilly. Drainage is well established and is frequently excessive. In places the soil is thin. The material is slightly finer in texture than that of the typical soils of the fine sandy loam group. The subsoil is similar to that of the fine sandy loam of the same series.

The surface material is a little more retentive of moisture than the fine sandy loam. In utilization and its adaptation to crops this soil does not depart materially from the fine sandy loam of the same series.

Vernon very fine sandy loam.—The soil is a red very fine sandy loam about 15 inches deep, and overlies a lighter red and heavier subsoil. The type is of residual origin and is derived from sandstone. In some places erosion has been severe, and the underlying red Permian sandstone is exposed or occurs as a bedrock substratum at shallow depths. The topography is rolling to hilly, and drainage is good to excessive. The agricultural value of the soil varies with the amount of erosion which has taken place. Where the soil is not too thin, and the topographic contour is favorable, corn and wheat give fair yields.

Area and distribution of the very fine sandy loam.

Soil name.	State or area.[1]	Acres.
Vernon very fine sandy loam	Kansas 6	7,680

[1] For key to number in this column see p. 733.

Loam Group.

The soils of the loam group are extensively developed and occur under a large number of important soil series. They are encountered in the northern part of the Great Plains province and in the middle and southern States. Some of the series include types which have a wide range in location from east to west, while others are either confined to districts of ample rainfall in the eastern section of the region or occupy western areas where they are not of great agricultural importance except under irrigation. Owing to this wide range in distribution and to their variation in topography, drainage, and character of underlying material, the loams vary widely in the purposes to which they are devoted and in the crops to which they are adapted.

Certain members of the group are locally or typically shallow and have a rough, broken topography. In general, however, depth of soil and topographic features are favorable to cultivation, root development, and to the effective use of farm machinery. Drainage is usually well established and is sometimes excessive.

While some members of the loam group occur under unfavorable conditions of water supply or of topography, transportation facilities, or character of underlying material, this is one of the most important soil groups in the Great Plains region and produces a great part of the grain and other general farm crops of the prairie States.

In the northern States wheat, oats, flax, corn, and millet are the principal products. In the middle States small grains, corn, and forage crops, consisting of sorghum, milo, kafir, broom corn, etc., are most extensively grown, while in the southwestern areas wheat, other small grains, and corn are less extensively grown than the more drought-resistant crops. In the southern States cotton is a staple crop. Vegetables are grown for home use throughout the region, and under favorable climatic, market, and transportation conditions they are produced commercially. Potatoes constitute an important crop. The soils are generally too shallow and unfavorably located for the successful culture of tree fruits, but peaches, apples, plums, etc., are profitably grown in small areas. In irrigated sections, alfalfa and sugar beets, as well as the staple grain crops, are extensively grown. Watermelons and cantaloupes, and peas for canning purposes are grown for market in certain local districts.

The subsoils are usually retentive of moisture. Some of the soils are sticky when wet and tend to puddle and bake, but owing to good natural drainage and to the prevailing structure and texture of the soil material it is usually friable under cultivation, is easily kept in good tilth, and when in such condition its water-holding power is high during the dry summer months.

The loam group requires a moderately heavy farming equipment. It is superior to the groups of lighter textured soils within this province for general farm crops, and is usually to be preferred for the production of vegetables excepting watermelons and truck crops for early market or grown under irrigation. When irrigated it is suited to the culture of sugar beets and, except in areas of thin soil, to alfalfa.

Benton loam.—The soil is rather fine silty loam usually reddish brown in color, extending to a depth of 6 feet or more. A compact, adobelike stratum, several inches thick, often occurs below the first 6 inches, or at a depth of 1 to 2 feet, a reddish, tough sandy clay of compact, adobe structure is encountered. This material is underlain by a stratum of sedimentary rocks. It sometimes contains gravel, consisting of angular fragments of sandstone and shale. This type occurs both in small and extensive areas of elevated, treeless plains. The topography is gently rolling or rather hilly. The surface of elevated areas is dissected by narrow valleys and deep perpendicular-sided arroyos or marked by drainage depressions. The higher elevations are rounded and often broken by outcropping sedimentary rocks. The soil is derived from residual material from shale, sandstone, and limestone. The type is usually well drained and free from alkali, except in local depressions, and is adapted to alfalfa, sugar beets, small fruits, and ordinary farm crops.

Bates loam.—The soil consists of a dark-gray or brown loose loam 8 to 15 inches deep. It is underlain by buff-colored sandy clay loam, which is usually mottled with red and yellow. A substratum of arenaceous shales and sandstone is encountered at depths varying from 18 inches to 6 feet. The soil is residual and derived from the weathering of these rocks. The type is usually well drained, and occupies areas of rolling topography. It occurs as treeless prairie in native condition and is devoted to general farm crops and vegetable

gardening. Corn, wheat, flax, oats, melons, and other truck crops are the principal products.

Clark loam.—The Clark loam is a dark-brown to black loam, quite heavy and sticky in places, although it contains large amounts of sandy material. It ranges in depth from 6 to 15 inches, and is underlain by a gray sandy clay or sandy loam. The subsoil is calcareous, and grades into beds of soft, chalky material containing lime nodules. Some mottling is frequently present in the subsoil. The topography is gently rolling to undulating, and drainage is good. The type is residual and derived from the weathering of consolidated calcareous material from the limestone forming the Mortar Beds phase of the Tertiary formation, probably modified by wind action. Only small areas of this type have so far been mapped, but where cultivated it produces fair yields of corn, kafir, sorghum, wheat, and alfalfa.

Cottonwood loam.—The surface soil consists of a dark-brown loam to silty loam, 8 to 12 inches deep, containing enough fine sand to make it quite friable. At a depth of 12 to 30 inches a substratum of gray or white, soft, impure gypsum is encountered. In some areas this rock lies so near the surface that it is turned up by the plow. The soil is mainly of residual origin and derived from gypsum lentils found in the Permian Red Beds. In places the superficial material consists of Tertiary or wind-blown material, and forms a thin layer over the gypsum. The soil is of low productiveness and is used principally for pasturage.

Crawford loam.—The soil is a brown to reddish-brown loam 12 inches deep. The immediate surface soil carries a large amount of fine sand and has the general appearance of a fine sandy loam. The subsoil is a heavy brown loam, passing usually at about 25 inches into a stiff, compact clay more nearly red in color. The type has a rolling topography and is well drained. It is not seriously eroded. The soil is of residual origin and derived from the weathering of sandy ferruginous clays, impure limestone, and sandstone. It is easily tilled, is well suited to cotton and corn, and produces fair yields of wheat and oats. Peaches, plums, small fruits, vegetables, and forage crops do well.

Englewood loam.—To a depth of 8 to 15 inches this soil is a dark-brown or reddish-brown loam, often containing more sand than a typical loam soil, but owing to a high clay content the soil is distinctly loamy. The subsoil is a brown or reddish-brown loam or clay loam. In some areas small knolls of gravelly soil too small to differentiate occur. The type is easily tilled on account of its rather high sand content. The topography is gently rolling and drainage is usually good. The type is classed as residual in origin, since the subsoils are residual from shale and sandstone material of the Permian Red Beds which they overlie, but the soil material includes a thin covering of unconsolidated Tertiary material. The Englewood loam is a fair agricultural type, and produces corn, kafir, sorghum, wheat and alfalfa. Small vegetables and some fruits are also grown.

Fort Collins loam.—The soil is a dark-brown or reddish-brown to almost black loam from 4 to 12 inches in depth. It is underlain by a layer of heavy loam from 1 to 4 feet in thickness, beneath which the subsoil grades into a light loam similar to the surface soil and extending to a depth of 6 feet or more. The soil becomes sticky when wet and bakes badly, often breaking into rough cubical blocks upon exposure after puddling. The surface is generally level, although occasionally slightly rolling or undulating, and sometimes pitted by erosion and cut by small intermittent streams. This is a residual type formed by the weathering in place of clayey or shaly sandstones and sandy shales. The soil is well adapted to wheat, oats, barley, alfalfa, sugar beets, potatoes, and apples.

Hermosa loam.—This type consists of a dark-brown, rather heavy and plastic loam about 14 inches deep, underlain by brown or gray heavy loam to clay loam similar in texture and structure to the soil material. At a depth of about 3 feet this becomes less plastic and more friable. A small amount of water-worn quartz and limestone gravel usually occurs. The material is of residual origin and derived from slightly consolidated deposits of the Tertiary, consisting of soft and calcareous sandstones and conglomerates. The type is closely associated with the Rosebud soils, but the material is of more local origin, having been brought down from the Black Hills immediately west of the area in which it is found. It occupies level to gently rolling plateau plains with steep slopes and rough hilly areas in the vicinity of streams. It is a productive soil, and under favorable moisture conditions is well suited to corn, small grains, potatoes, and other general farm crops.

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Kildeer loam.—The Kildeer loam consists of a dark-gray to dark-brown loam from 10 to 20 inches deep, underlain by light-gray to light-brown loam. The soil is calcareous, friable, and readily maintained in a good condition of tilth. It is residual, and formed mainly from the weathering of limestone and calcareous shales. The type occupies elevated plateaus and buttes. The surface is rough and rocky at higher altitudes to smooth and more gently sloping at lower levels. The slopes are frequently broken by rock outcrop, and are often too steep and broken for successful cultivation. The arable areas are adapted to the production of wheat, oats, and corn.

Morton loam.—The soil to a depth of 18 inches is a brown loam with a large percentage of silt. This passes in many places into a silt loam. The subsoil is typically a light-brown to light-gray silt loam, which usually extends to a depth of 40 inches or more. This is underlain by a stratum of bedrock. The topography includes broad valleys and rolling hills. The natural drainage is good, and moisture is well retained. The type is of residual origin and is derived from calcareous sandstones of the Laramie formation. Some stones occur on the hills. This soil is productive, and good crops of wheat, flax, oats, corn, millet, and vegetables are secured. On areas of rougher topography pasture is most profitable.

Sidney loam.—The soil is light brown and 10 to 16 inches deep, and it is usually somewhat silty and is rather compact. The subsoil is light gray to white and contains excessive amounts of lime, with an admixture of coarse sand and gravel. In places it consists of a compact bed of cemented gravels. The type occupies level to gently rolling areas, and is usually well drained. It is residual and derived from soft, partially consolidated, calcareous conglomerate, sand, silt, and clay deposits. It is little used, except for grazing. Where the rainfall is adequate the soil is adapted to small grains, corn, sorghum, and other forage crops.

Spearfish loam.—This type includes a chocolate-brown to reddish-brown loam to silty loam about 8 inches deep, underlain by a reddish-brown to red heavy loam to silty clay loam. This rests upon a stratum of gypsum-bearing shales and sandstones. The type is of residual origin and is derived from the weathering of the Spearfish Red Beds. It closely resembles the Vernon soils of Oklahoma and Texas. Where not too shallow it is a very productive soil, and when irrigated or when moisture conditions are favorable it produces good crops of wheat, oats, alfalfa, and potatoes. The soil is also well suited to the production of fruit.

Vernon loam.—The surface soil of the Vernon loam consists of 6 to 10 inches of reddish-brown or reddish loam, containing a high percentage of very fine sand and a rather large amount of silt. The subsoil to 36 inches is a red, reddish-brown, or reddish-yellow heavy loam. In some areas gypsum is found either exposed or at a slight depth beneath the surface. The soil is residual, and has been derived from the weathering of the shale and sandstone rocks of the Permian Red Beds. The surface is gently to moderately rolling, but large areas are badly eroded and the cultivation of large connected areas is usually impossible. It is a strong, productive soil, and gives good yields of kafir, milo, sorghum, wheat, oats, and cotton.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Vernon loam	Texas 22	732,672
Sidney loam	Nebraska 7	705,024
Spearfish loam	South Dakota 3	200,448
Morton loam	North Dakota 7	163,456
Hermosa loam	South Dakota 3	119,808
Bates loam	Missouri 3, 5	92,416
Benton loam	Colorado 2	78,784
Kildeer loam	North Dakota 10	46,080
Fort Collins loam	Colorado 2	14,144
Clark loam	Kansas 6	11,520
Englewood loam	do	7,232
Crawford loam	Texas 31	6,784
Cottonwood loam	Texas 22	2,304
Total		2,180,672

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The soils of the stony loam phase of the loam group resemble the loams of the same series in texture of the interstitial soil material, but are distinguished by the presence of stone fragments or bowlders in quantities large enough to influence the possibilities and methods of crop production, the drainage of the soils, and their relation to moisture supply.

The stony loams have been encountered under several of the soil series of the Great Plains region. They are widely distributed and in some districts cover extensive areas.

The stone and bowlders interfere with the use of farm machinery, and considerable expense and labor is necessary in clearing the land. The prevailing topography is sharply rolling to rough, and the surface is frequently so dissected or interrupted by outcropping ledges of rock as to render large areas unfit for cultivation. The soils are usually shallow. Drainage is generally excessive, and the soils are sensitive to drought.

The stony loams are not extensively utilized except for pasture, and are best adapted to grazing. They are of some importance in connection with the grazing industry, and local areas are capable of producing forage crops or grains. On some of the timbered areas in districts of ample rainfall forestry should be practiced.

Benton stony loam.—The soil is a light-brown to grayish-brown loam, containing small shale and limestone fragments throughout the soil material and on the surface. The subsoil is light gray, and is made up largely of partially weathered shale and limestone fragments. The type occupies eroded and dissected regions of rough, broken topography, and is well drained. The soil is residual and derived from shale and limestone material. It is underlain by a bed rock stratum, usually at shallow depths. The underlying shale and limestone rocks are exposed in places as eroded surfaces or as outcrops. The type is not retentive of moisture, and owing to this feature, together with its shallow depth and rough topography, it is generally devoted to grazing. Where topographic and climatic conditions are suitable forage crops, such as kafir, sorghum, etc., may be grown in connection with stock raising.

Boone stony loam.—The interstitial material varies from a brown loam to a light-brown sandy loam, and in a few places to a gray sand. The soil is from 6 to 15 inches deep, and contains broken fragments of brown sandstone varying considerably in size. The subsoil is a yellow loamy clay with dull red mottlings, and is very stony. This is underlain by a stratum of unweathered bedrock, occurring at from 2 to 4 feet. The type is of residual origin and is derived from shales and sandstones. The topography is rolling to steep along valleys and on narrow divides. The greater part of the type is timbered, though a few areas of prairie land occur. It has little agricultural value, and is best adapted to pasturage and forestry.

Clark stony loam.—Over most of its area this type is rough and stony. In the small areas of tillable land the typical soil is a light to dark brown or dark-gray silt loam, ranging in depth from 6 to 18 inches. The subsoil is a lighter-colored silt loam. Both soil and subsoil contain fragments of calcareous rocks. In the rougher areas a limestone substratum outcrops in great blocks or ledges, and loose fragments are scattered over the surface. The type represents the exposure and partial weathering of calcareous strata of the Tertiary, underlying the Plains Marl. On the arable land wheat, corn, and the sorghums produce fair yields.

Eldorado stony loam.—This is a dark-brown loam 12 to 15 inches deep, underlain by a yellow or gray loamy clay with red mottlings. The subsoil becomes redder with depth. Angular chert fragments constitute from 10 to 20 per cent of the soil material and a somewhat greater part of the subsoil. The soil is easily cultivated, except where the stone content is too great, and produces good crops of wheat, corn, and grass. The type is derived from the weathering of Burlington limestone, and is of residual origin. It forms a part of the original prairies. The topography is rolling and drainage is good.

Morton stony loam.—The interstitial earth consists of 6 to 12 inches of brown fine sandy loam or yellowish brown silt loam. The subsoil is a yellowish-brown silt loam. From 10 to 50 per cent of gravel, stones, and bowlders occurs on the surface and through the soil. The gravel and bowlders are largely granitic and of glacial deposition, the finer glacial material having been removed by erosion. The stones are largely sandstone and chert, derived from underlying rocks. The type usually occupies low, narrow ridges and rounded knolls or

hilly regions subject to erosion. Drainage is thorough to excessive. While the type is largely devoted to pasture, small tracts may be utilized for producing winter feed and potatoes or vegetables.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Benton stony loam	Kansas 10; Nebraska 7	688,896
Clark stony loam	Kansas 10	161,280
Morton stony loam	North Dakota 6, 7	48,128
Eldorado stony loam	Missouri 5	28,224
Boone stony loam	do	10,432
Total		936,960

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

While the stony loams of the residual province in the Great Plains region have been quite extensively encountered in the soil survey, the gravelly loam has been recognized under only one soil series.

The subsoil is heavy and compact and is retentive of moisture, but a high gravel content in both soil and subsoil, with the predominant rolling topography, renders both surface and subdrainage excessive. The soil is of greater average depth than that of the stony loams of the province, and its general features are superior, yet it is much inferior to the soils of the loam group in adaptation to agriculture, particularly under conditions of light rainfall. It is best suited to pasture, but where the gravel content is not excessive corn is grown to some extent with a fair degree of success in favorable seasons. In favorable locations a part of the type could probably be utilized for the production of peaches and grapes.

Crawford gravelly loam.—The soil is a very dark to black, compact gravelly loam, with a depth of about 8 inches, and contains from 10 to 50 per cent of rounded chert fragments of a reddish tinge. The subsoil is a red, very stiff, tenacious clay, in which small quantities of similar gravel usually occur. The gravel content varies greatly in both soil and subsoil. The soil is residual, and is derived from limestone. The type occupies knobs and ridges, which rise from 5 to 30 feet above the general level. The topography is thus rolling, and affords good surface drainage. The gravel in the soil permits ready subdrainage. The type as a whole is best adapted to pasture, but where the soil is not too gravelly corn is successfully grown, especially in wet seasons. Grapes, peaches, and some other fruits would probably do well on some areas.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Crawford gravelly loam	Kansas 1	5,165

[1] For key to number in this column see p. 733.

LOAM ADOBE PHASE.

The adobe soils are not widely developed in the Great Plains region, and are confined to the western arid districts, where they have been recognized under one soil series. This soil is more tenacious and refractory when wet than are the normal members of the loam group, and it has a pronounced tendency to puddle and to bake and check upon drying. When properly managed and thoroughly cultivated the soil is friable and retentive of moisture. Drainage is sometimes rather poorly developed.

The loam adobe soil requires a somewhat heavier type of farming equipment than the loam soils. In general adaptation to crops it is more closely related to the soils of the clay loam than to those of the loam group. The rainfall is usually too light for the growing of crops without irrigation. Under irriga-

tion and favorable drainage conditions the soil is well adapted to a heavy type of farming and the production of grains, alfalfa, forage crops, and sugar beets.

Benton loam adobe.—This soil has a compact, adobelike structure, checking into cubical blocks upon exposure, but breaking into a loamy tilth when cultivated under favorable moisture conditions. It grades from a fine sandy loam to a heavy loam in texture, is usually without gravel, and is yellowish or reddish brown to dark brown or dark gray. It is usually 6 feet or more in depth, and is underlain by sandstone, limestone, and shale. The type occupies hilly to low, gently undulating slopes, local drainage depressions, and narrow areas bordering arroyos. It is derived from underlying sedimentary rocks, modified by alluvial wash from higher slopes, and by wind-blown material. Gypsum and lime are frequently encountered in large quantities. The soil retains moisture and is adapted to alfalfa and grains when capable of irrigation. It is generally free from accumulation of seepage waters or alkali from the irrigation of higher lands.

Area and distribution of the loam adobe.

Soil name.	State or area.[1]	Acres.
Benton loam adobe	Colorado 2, 3	42,880

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

The soils of the silt loam group are extensive and widely distributed and are represented in a greater number of important soil series than are the soils of any other group within the residual province of the Great Plains region.

Their extensive occurrence gives a wide variation in rainfall and other regional climatic conditions. They also vary more in topography, drainage, depth, character of subsoil or other underlying material, and in moisture-retaining capacity and relation to agriculture than any other soil group or group phase in the province.

Most of the silt loams occur in areas of comparatively level to undulating topography, are of good depth, and are underlain by subsoils which are somewhat heavier and more compact than the surface material. Surface drainage is fairly well established, but subdrainage is generally poor, owing to relatively impervious subsoils. The soil is usually friable under cultivation and retentive of moisture. Some of the members of the group, however, occupy areas of rough, broken topography, frequently broken by outcropping ledges of rock, and are excessively drained, subject to erosion, and often of shallow depth. In some types the subsoils are of porous character; in others they are so dense and intractable as seriously to retard subdrainage and root development. In some members the soil material is easily puddled and is maintained in a favorable structural condition only with difficulty. Some of the members of the group are the best soils for general farming within the districts in which they occur. Others are unproductive and not retentive of moisture and are adapted only to grazing or forestry.

With respect to agricultural use and possibilities of development, the silt loams average somewhat lower than the loam group of the province. In certain series, however, they may be superior to the loams.

The arable and productive members of the group are devoted almost exclusively to general farming, the principal crops consisting of wheat, oats, corn, flax, clover, timothy, and other grasses. Kafir, sorghum, millet, broom corn, and similar crops are extensively grown, particularly in districts of light rainfall. Alfalfa and sugar beets are important crops in some localities, especially in the irrigated areas. Potatoes, tobacco, cantaloupes, and garden vegetables, and apples, peaches, plums, and berries are local products of some importance.

The soil requires a moderately heavy farming equipment, and careful management and thorough cultivation is necessary. It is adapted to a rather heavy type of general farming, and under favorable conditions of climate, natural water supply, and irrigation, and where transportation and market facilities are available, such special products as heavy and late vegetables, cantaloupes, and sugar beets can be profitably produced.

Bates silt loam.—The soil is a dark-gray, mellow loam, which changes to a yellowish-gray silt loam at a depth of 8 to 10 inches. This is underlain at 20 to 36 inches by a yellow and red mottled clay loam or silty clay subsoil which becomes slightly heavier with depth. Iron nodules and bands of soft, imperfect iron hardpan occur in the subsoil material. The type is of residual origin and is derived from the soft shales and sandstones which immediately underlie it. In its native condition it is treeless prairie, but the soil is valuable for general farming and large areas are under cultivation. The principal products consist of corn, wheat, flax, and hay.

Belvidere silt loam.—The type consists of a grayish-yellow to brown silt loam 10 to 14 inches deep, underlain by a grayish-yellow, loose silt, containing flakes and fragments of shale. This is underlain by a bedrock stratum occurring frequently within 3 feet of the surface. The soil is hard and compact and cracks when dry. Fragments of anhydrite and fossiliferous limestone occur in both soil and subsoil. The type is residual, and has been derived from dark-colored shale. Owing to its shallow character and rough broken topography it is not adapted to crop production, and is used only for grazing.

Benton silt loam.—The soil is a light yellowish-brown or buff silt loam. It is somewhat sticky when wet, but friable under cultivation. The upper subsoil is a light brown rather compact silt loam, while the deeper subsoil is light brown to light grayish brown in color and of more porous structure, is usually calcareous, and often contains gypsum crystals. The type is of residual origin from calcareous shales, shaly limestones, and to some extent from interbedded sandstones. There is some admixture in places of waterworn gravels or of finer angular material of granitic origin from Tertiary or from early alluvial deposits. In general the topography is nearly level or undulating, but local rough eroded areas occur. The soil is easily eroded and is generally well drained except in local depressions or where seepage waters from irrigation accumulate. Where climatic, irrigation, and drainage conditions are favorable, the type is adapted to a wide range of general farm and special crops, and is extensively utilized for the production of alfalfa, forage crops, melons, and sugar beets.

Boone silt loam.—The soil consists of from 6 to 15 inches of a very light gray, floury silt loam, and is underlain by a yellow or mottled yellow and gray, rather compact silt loam or light clay loam. The type is residual and is derived from shales. Its topography is comparatively level to sloping. The timber growth is principally oak and hickory. The soil is very low in humus, and can be improved by the addition of organic matter. Very little of the type is under cultivation and the yields are rather low.

Castleton silt loam.—The surface soil to about 12 inches is a dark grayish or grayish brown heavy loam. The substratum consists of disintegrated gray clay and shaly limestone. This is underlain at 20 to 36 inches by a stratum of limestone bedrock which is so thin and broken that the soil auger passes through it into the red clay beneath. The type is encountered as small areas along the escarpment between the Tertiary and Permian formations. It occupies shelf-like positions which represent the highest horizon of the Permian Red Beds. The soil is residual from shaly limestone of the Permian. Its topography is nearly level to gently undulating, and narrow areas of the type have been cut by streams and reduced in extent by erosion. Owing to its thin soil and the impervious underlying material, the type is droughty. The soil is cultivated in places and during good seasons fair yields of corn and wheat and good yields of kafir and sorghum are produced.

Crawford silt loam.—The soil to an average depth of about 10 inches is a reddish-brown to dark-brown friable silt loam, which has a decided tendency to dry out in periods of drought, making frequent cultivation necessary. The subsoil is a red or brown silt loam or clay loam, generally somewhat open and granular, but becoming more compact and stiffer with increased depth. The type is residual and derived from limestone, which is frequently encountered 2 to 5 feet below the surface. It occupies level to rolling prairies and is well drained except in depressions and flat areas, where it is generally best suited to pastures. The soil is particularly adapted to corn, but all general farm crops, as well as fruit and vegetables, do fairly well. Corn, wheat, oats, and hay are the principal products. Alfalfa, clover, and timothy are grown to a limited extent.

Dodgeville silt loam.—This soil is a dark-brown to nearly black silt loam 8 to 12 inches deep, and overlies a more compact subsoil, changing to a light-reddish or buff color, particularly at lower depths, where it frequently rests directly

upon a bedrock substratum. The type is of residual origin, but includes a slight admixture of loessial material. It is derived from limestone. The limestone is often quite granular in structure, so that the soil material appears sandy at the point of contact. The soil occupies gently rolling to hilly areas, and is well drained. It is adapted to general farm crops, particularly hay, corn, and the small grains.

Englewood silt loam.—This type consists of a light to dark brown silt loam containing considerable very fine sand, 18 to 20 inches deep, underlain by a light-brown to reddish-brown silt loam, which extends to more than 3 feet. The soil is easily tilled. The type is of residual origin, and is associated with the soils of the Vernon series. It is derived from shales and sandstones of the Permian Red Beds, but includes in the surface soil some material from unconsolidated Tertiary deposits or from other sources. It is more deeply weathered than the Vernon soils. It is very productive and is adapted to small grains and corn.

Epping silt loam.—The soil is a silt loam of light yellowish gray or buff and sometimes of flesh color. The subsoil is generally similar in color and character to the overlying material. The type is of residual origin and derived mainly from the weathering of underlying clay of the Brule formation. It occupies rolling or undulating plains, which are frequently excessively eroded and dissected and which merge into areas of "bad lands" or rough, broken land. Drainage is generally well established. The soil and subsoil are deficient in organic matter and are of compact structure. The type is rather refractory when first placed under cultivation, but with proper management and thorough cultivation it becomes friable. The rougher areas or those not capable of irrigation are generally used for grazing. Irrigated areas are devoted to the successful production of alfalfa, wheat, barley, and potatoes.

Gasconade silt loam.—The soil consists of 8 to 12 inches of dark-gray to black silt loam. The subsoil is a heavy mottled silt loam, grading below 36 inches into a gray and red mottled silty clay. The subsoil rests in places upon unweathered limestone at a depth of 4 to 6 feet. The type occupies gently rolling prairie uplands, and usually has good drainage. It is a residual type derived from limestones. The soil is productive and nearly all of it is under cultivation. Corn yields from 20 to 45 bushels per acre, and wheat, timothy, and clover do well.

Gerald silt loam.—The soil to a depth of about 4 to 7 inches is a gray or grayish-brown to light-brown floury silt loam. On the more nearly level areas the color is usually lighter and iron concretions occur, the reverse being true in the more sloping situations. The subsoil is a light-brown or yellowish-brown silty clay loam, grading into a deeper heavy plastic clay subsoil of light or dingy brown or snuff color, frequently mottled with gray in the lower section. Over the crests of ridges and flat areas the heavy clay often extends to a depth of 36 inches or more, but on the steeper slopes the lower portion of the subsoil is often more friable or sandy than the overlying subsoil section. The heavy intractable clay subsoil interferes with root development and the downward movement of moisture. Prevailingly the topography is gently to strongly rolling, and surface drainage is good, but the flat areas are poorly drained. Most of the type is covered with a stunted growth of post oak, blackjack, some white oak, and hickory. Owing to the poor underdrainage and the heavy silty texture of the soil, this land warms up slowly in the spring. Ordinarily the yields of the most important crops grown are 10 to 12 bushels of wheat, 15 to 25 bushels of corn, and 15 to 30 bushels of oats. Cowpeas and bluegrass do well.

Hannibal silt loam.—The type includes a dark-brown silt loam 8 to 10 inches deep underlain by a bright yellow or greenish-yellow silty clay, which becomes more tenacious with depth. The soil contains a varying amount of sandstone fragments. Relatively small areas of the type are developed along streams where the valleys have been cut down to the underlying shale, the soil being a residual product of the weathering of this material. It occurs as gentle slopes or benches just above the alluvial bottoms, and sometimes occupies step, gullied hillsides. Low-lying areas are sometimes poorly drained. As a rule, however, the drainage is fairly good. Wheat and corn are the principal crops. The soil is especially adapted to wheat.

Morton silt loam.—The soil consists of 6 to 10 inches of gray or yellowish-brown friable silt loam. The subsoil to a depth of 24 inches is a yellowish-gray silt loam or silty clay, beneath which a compact silty clay of somewhat

lighter color occurs. The surface 12 inches contains a high percentage of organic matter, which renders the structure fairly loose and open. The greater part of the type has sloping or gently rolling topography. This facilitates good drainage, which is very important, as the soil becomes plastic when wet. This is an extensive upland type, and is residual, being derived from fine-grained sandstone, but on some slopes colluvial material is also locally included. Narrow ridges of fine glacial gravel occur, the finer glacial material having been removed by erosion. As a rule the soil is free from injurious amounts of alkali, but the presence of some salts is frequently indicated by a thin white crust. The type is treeless, the vegetation being native grasses. The soil has never been cultivated, and wild hay and pasture are the only products. Small grains, hay, and potatoes should do well with sufficient rainfall.

Oswego silt loam.—The soil is a gray to dark-gray or yellowish-brown silt loam, 6 to 20 inches deep, grading into a drab to yellow stiff silty clay, which becomes stiffer and more impervious as depth increases. The type occupies level to gently rolling upland prairies. It is of residual origin and derived from shale, with occasional interbedded layers of sandstone or limestone, and in places outcrops of bituminous coal. When dry the soil is likely to bake and check, but breaks up into a mellow loam when plowed. Surface drainage is usually well established, but subdrainage is deficient. This is a soil of fair productivity, and is used for general farm crops. The average yield of wheat is about 18 bushels, of corn 25 bushels, and of potatoes 80 to 100 bushels per acre. Flax, rye, broom corn, oats, clover, timothy, alfalfa, forage crops, and fruits are grown to some extent.

Sidney silt loam.—The soil is brown and usually extends to a depth of 12 to 18 inches, but areas of thin surface soil of grayish-brown color occur on slopes. Water-worn gravel and calcareous fragments often occur. The subsoil is white, silty, and calcareous, the lime content being excessive. It occasionally contains gravel and soft calcareous fragments. The type is underlain by soft, cemented, calcareous material of the Mortar Beds, but this substratum is not near the surface. The soil occupies slightly undulating or gently rolling areas, and is well drained. It is of residual origin and is derived from calcareous grit or soft limestone interbedded with silt and clay, containing gravel and calcareous nodules. The type is utilized mainly for grazing and for the production of small grains. Under favorable climatic conditions it is adapted to wheat, oats, corn, and forage crops.

Summit silt loam.—The surface soil of this type is uniformly a dark-gray or black rather heavy silt loam, which has a tendency to constant granulation. At about 10 inches below the surface the material becomes lighter in color, and the subsoil is mottled yellow and gray. The granular structure is maintained to about 20 inches, at which depth the subsoil grades into a deeper subsoil of yellowish or slightly greenish tinged gray silty clay. The type is of residual origin and is derived from calcareous shales. Outcrops of thin strata of limestone occur, and these have given rise to the impression that the soil is derived from limestone, "black limestone land" being a popular name. The soil occupies areas of rolling topography, and is usually confined to narrow ridges and slopes and higher mountlike elevations. Surface drainage is well established, but percolation and subdrainage take place slowly. The type was originally covered with prairie grasses, but is now largely cultivated and is considered a strong soil for general farm crops. It is particularly adapted to corn, wheat, and flax. Alfalfa and grass crops are successfully grown to a limited extent.

Vernon silt loam.—The surface soil is a reddish-brown to dark-brown silt loam 12 inches deep, and is mellow, friable, and easily worked. The subsoil is a light reddish brown compact silt loam, heavier in texture than the soil, but at from 3 to 6 feet it is underlain by a friable red clay. The subsoil frequently contains lime concretions and locally becomes grayish and sticky when moist. The type occupies level and slightly rolling areas of the prairie upland, and is fairly well drained. It is of residual origin and is derived from shale and sandstone material of the Permian Red Beds. Corn, wheat, oats, kafir, and sorghum are the principal crops grown. The soil is particularly adapted to wheat.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Sidney silt loam	Nebraska 7	1,405,440
Oswego silt loam	Kansas 1, 4, 7, 9; Missouri 3, 5, 6	783,616
Vernon silt loam	Kansas 10; Oklahoma 1; Texas 30	768,768
Crawford silt loam	Kansas 1, 11; Missouri 3, 10	320,039
Epping silt loam	Nebraska 7	313,344
Benton silt loam	Colorado 3	236,288
Summit silt loam	Missouri 3, 10	228,480
Englewood silt loam	Kansas 10	145,152
Morton silt loam	North Dakota 6	104,576
Boone silt loam	Missouri 3, 6	80,192
Gerald silt loam	Missouri 8	80,000
Bates silt loam	Missouri 3, 6	64,256
Dodgeville silt loam	Wisconsin 5	56,128
Belvidere silt loam	Kansas 10	23,040
Gasconade silt loam	Arkansas 2; Missouri 7	16,320
Hannibal silt loam	Missouri 5, 13	14,848
Castleton silt loam	Kansas 6	2,944
Total		4,643,431

[1] For key to numbers in this column see p. 733.

STONY SILT LOAM PHASE.

The stony silt loam phase has been encountered under one soil series. Both soil and subsoil contain a large amount of chert fragments. The type occupies rolling topography and is well drained and productive. While the porosity of the soil and subsoil is increased to some degree by the stone content, the type occurs in districts of fairly well-distributed rainfall, and drainage, while ample, is not usually so excessive as seriously to impair the productiveness of the land. The soil is friable under cultivation, but the stone content is sometimes sufficient to interfere somewhat with the use of farm machinery. The type is almost exclusively devoted to general farm crops. It is probably superior to the normal members of the silt loam group for the production of apples or other fruits, which can be produced successfully where markets and transportation facilities are good.

Wagoner stony silt loam.—The soil is a gray to light-brown silt loam 12 to 15 inches deep and is underlain by a granular yellow or gray friable loamy clay mottled with red. Scattered through the soil and subsoil are 50 per cent or more of angular chert fragments, a large part of which is often concentrated about a foot below the surface. The topography is rolling and drainage is good. The type was originally timbered with black oak, post oak, and hickory. The soil is derived from the weathering of Burlington limestone and is of residual origin. It is a good agricultural type, and is especially adapted to grass. Fruit does well.

Area and distribution of the stony silt loam.

Soil name.	State or area.[1]	Acres.
Wagoner stony silt loam	Missouri 5	41,984

[1] For key to number in this column see p. 733.

CLAY LOAM GROUP.

The residual soils of the clay loam group are widely distributed throughout the Great Plains region, and in some districts cover large areas, but they are less extensive than those of either the loam or silt loam groups. They have been recognized under several of the more important soil series.

The soils are subject to a wide range in climate and to some local variations in topography, depth, character of underlying material, and drainage. They are generally of good depth and drainage is fairly well developed. The topography is usually nearly level to undulating or gently rolling. The soil is rather sticky and intractable when wet and bakes and puddles somewhat

under poor drainage or inefficient management. It is usually friable where properly cultivated and is retentive of moisture. The subsoils are predominantly rather heavy and compact and their moisture-holding power is high, but where drainage is not well developed they render the soil rather wet, cold, and late. The underlying stratum of bedrock occasionally occurs at shallow depths.

The clay loams require a heavy farming equipment and somewhat more careful management than the soils of the loam group. They are somewhat less productive than the loam and are adapted to a somewhat narrower range of crops. In general they are moderately productive and are devoted almost exclusively to general farming, to which they are well adapted, the principal products consisting of wheat, oats, corn, timothy, clover, and alfalfa. Local areas in the southern districts are adapted to cotton. The type is generally capable of producing fruit and vegetables for home use, but conditions are not usually favorable to their commercial production. Sparsely settled and poorly drained areas are devoted to grazing.

Bates clay loam.—The soil is a brown or dark-gray loam, carying from 10 to 15 inches deep and underlain by a dark-gray or dull-yellow clay loam mottled with reddish brown. A few sandstone fragments occur in the soil and subsoil, and a substratum of partially weathered sandstone rock is often encountered at depths of 3 to 6 feet. The topography is level to gently rolling, and drainage is generally good. The soil is of residual origin and is derived from interbedded sandstones and shales. It occupies flat-topped divides and saucer-shaped valleys. The type is usually prairie, though a darker colored, thinner phase is sometimes found covered with blackjack, post oak, and black oak. It is moderately productive and is utilized mainly for the production of corn, wheat, and timothy.

Clark clay loam.—The type consists of a dark-brown or black clay loam about 10 inches deep, overlying a gray calcareous clay subsoil which contains a large amount of soft white chalky material which often extends to a depth of several feet. The soil is quite heavy and clods when wet, though if cultivated under favorable moisture conditions the soil has good tilth and resembles a loam in structure and texture. The topography is undulating to nearly level, and drainage is poor, so that water stands at the surface for a short time. The type is residual and derived from the weathering of the consolidated calcareous material or limestone of the Mortar Beds phase of the Tertiary formation, possibly modified by the addition of sandy material transported by winds. The soil is productive and is extensively used for the staple farm crops. Alfalfa, wheat, and other small grains are grown with good success.

Crawford clay loam.—This type includes 8 inches of chocolate-brown silty clay loam, underlain to a depth of 3 feet by light-brown, chocolate, or reddish-brown silty clay. A bedrock substratum occurs at 2 to 4 feet. The type is of residual origin and is derived from the weathering of limestone. It is considered a desirable soil, and is easily cultivated and very productive. The topography is gently rolling or rolling. The type is well drained and adapted to cotton, corn, wheat, and oats, being especially suited to small grains.

Morton clay loam.—The soil is a heavy silty clay loam to a depth of 6 to 16 inches and contains sufficient humus to give it a dark-brown color. The subsoil is a heavy silty clay loam or clay, ranging in color from gray to drab. Where this material is exposed at the surface it is locally known as "gumbo." The type occupies upper slopes of hills, and the topography is generally level or gently sloping. Drainage is well established, except on the more level areas. The type is residual and owes its origin to the outcropping and weathering of fine-grained calcareous shale and sandstone rocks, mainly of the Laramie formation. It is usually retentive of moisture. White alkali is present in very small areas. This is a good grazing soil, and could be utilized for the production of hay and grain crops.

Pierre clay loam.—The soil consists of 12 to 30 inches of light-brown heavy clay loam. This is underlain to 6 feet by a brown very heavy tenacious clay. In parts of the subsoil small rough cubical fragments of grayish or light-brown color derived from clay concretions in the Pierre shale occur. Below 6 feet the soil contains a heavy clay to a depth of 10 to 40 feet or more, where it is underlain by a heavy blue clay. Small quantities of water-worn gravel sometimes occur. The type occupies low, poorly drained areas and the slopes of foothills, and the drainage varies accordingly. The type is residual from shale, but it includes locally some alluvial surface material derived from wash from adjoining higher shale material. It is sometimes difficult to handle on account

of its heavy nature. Alkali is injurious in certain sections. The soil supports a good growth of grass and is used for grazing to some extent. Good yields of alfalfa, oats, wheat, and corn are secured by dry-farming methods. Irrigation is also practiced.

Summit clay loam.—The soil is a dark-brown to black clay loam and contains minute particles of mica. The subsoil, beginning at about 15 to 18 inches, is a mottled yellowish and gray stiff clay loam to clay. The type is derived from shales and is of residual origin. It is influenced by limestone, owing to wash from higher soils, and in places by material from thin beds of included limestone. Corn, wheat, and other grain are the chief crops. Fair yields are secured.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Bates clay loam	Missouri 5	25,344
Pierre clay loam	South Dakota 1	24,192
Clark clay loam	Kansas 6	23,232
Summit clay loam	Missouri 10	20,224
Morton clay loam	North Dakota 6, 7	17,024
Crawford clay loam	Texas 9	8,448
Total		118,464

[1] For key to numbers in this column see p. 733.

STONY CLAY LOAM PHASE.

The stony clay loam in this province has been encountered under but two soil series. The topography is rolling. The soil contains rock fragments in amounts sufficient to interfere with cultivation and to render the soil and subsoil of open, porous structure. It is deficient in moisture-retaining capacity and departs widely in agricultural importance from the clay loam members of the same series. It is utilized mainly for pasture and is best suited to grazing.

Brackett stony clay loam.—The soil is a light-gray clay loam and contains a large amount of limestone fragments. The subsoil is similar in color and in texture and is underlain at shallow depths by a chalky limestone. Outcrops of this rock are frequently exposed along eroded slopes. The soil is of residual origin and derived from the underlying material. It is usually deficient in humus and high in content of lime. The topography is usually rough or rolling and dissected. Drainage is well developed. Owing to the shallow depth of the soil, the excess of stone fragments, the low moisture-holding capacity, and to the semiarid conditions under which the type occurs, it is utilized mainly for grazing and is best adapted to this purpose.

Crawford stony clay loam.—The soil of this type is dark brown to reddish brown. It is friable under cultivation and somewhat subject to drought. The subsoil is reddish brown or red and becomes compact with increasing depth. This type is residual and derived from limestone. This rock frequently occurs as a substratum at shallow depths. The topography is rolling. Chert, limestone, and shale fragments are present in such amounts that the type is of very little use except for pasturage.

Area and distribution of the stony clay loams.

Soil name.	State or area.[1]	Acres.
Brackett stony clay loam	Texas 28	391,680
Crawford stony clay loam	Missouri 10, 16	39,872
Total		431,552

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loam soils of this province have been recognized under several important soil series. In importance and extent they are about equal to the clay loams, but are less widely distributed.

The topography is usually undulating, but sometimes comparatively flat. Drainage is generally good, although it is imperfectly developed in some of the low, flat areas. The subsoils are heavy and compact and are often relatively impervious. This retards subdrainage and renders the soil usually rather late and wet. The soil is generally compact and intractable where poorly drained and improperly cultivated, but where moisture and tillage conditions are favorable it is friable and capable of being maintained in a good tilth.

The silty clay loams are productive and return good yields of corn, wheat, oats, clover, and timothy. In the western and southwestern arid districts drought-resistant crops, such as kafir, milo, millet, and sorghum, are more extensively grown and give more certain yields. Alfalfa may be successfully grown under irrigation or where the natural moisture supply is ample, except in local shallow or poorly drained areas.

The silty clay loams are adapted to heavy general farming and require a heavy farming equipment. In the purposes to which they are devoted and in adaptation to crops they do not depart greatly from the normal clay loams, but they are slightly heavier and require more careful management and thorough tillage.

Crawford silty clay loam.—The soil is a dark-brown or brownish-red silty clay loam, and overlies a decidedly brownish red or red subsoil of heavier texture. Limestone fragments and iron concretions are frequently present. The topography is rolling to sloping and surface drainage is usually good. The soil is derived from the residual weathering of limestone with some interbedded shale. The soil is rather granular, and notwithstanding its heavy texture it can be maintained in good tilth if cultivated under favorable moisture conditions.

Gasconade silty clay loam.—This soil ranges from about 10 to 18 inches in depth and consists of a black, friable, heavy silt loam to silty clay loam, the clay content increasing with depth. The soil is deepest in lower situations where there has been some local accumulation of colluvial material. The subsoil is a heavy clay of decided plasticity when wet, with some variations in color. On drying in exposures it has a tendency to crumble, as do many calcareous clays. Usually the color is a very dark brown or brownish black in the upper part, but this quickly gives way to a mottling of brown, yellowish brown, and brick red. With increase in depth a gray color frequently appears, while the yellow and red become less pronounced. Rock fragments, consisting principally of limestone, occur on the surface and in the lower subsoil. Limestone outcrops are common. The surface is undulating and the type occurs chiefly in basins in the vicinity of streams. In general drainage is good, but a few places are kept permanently soggy by springs. The type is residual and is derived from massive limestone, which is mainly chert free. At least a part of this soil was originally treeless. Post oak, walnut, wild plum, locust, elm, laurel, and hawthorn have spread over a part of the type. The type is productive and corn yields up to 60 bushels per acre. Clover, timothy, and wheat do well.

Kirkland silty clay loam.—The surface soil to an average depth of about 10 inches consists of a dark-brown to slightly reddish-brown silty clay loam, and is underlain by a heavy silty clay loam or silty clay of a brown or yellowish-brown color. The topography is gently rolling. The soil is of residual origin and has been formed from the weathering of the nonred sandstone and shale rocks of the Permian. It is close and compact and crops suffer during dry years. Kafir, milo, sorghum, and millet are the surest crops, although alfalfa, wheat, oats, and corn do well when moisture conditions are favorable.

Oswego silty clay loam.—The soil to an average depth of about 12 inches is a dark-gray to nearly black silty clay loam. The subsoil is a heavy, rather impervious silty clay, which is either dark drab or black in color, or in places light drab below about 26 inches. Lime and iron concretions sometimes occur in the subsoil and soil. The topography is nearly level. The type occupies shelf-like positions, somewhat resembling terraces, along streams. The soil is residual from the weathering of shales, possibly interbedded with thin strata of limestone. It is a true upland type notwithstanding its terracelike position,

and is not subject to overflow. The moisture conditions of this type are better than those of the higher lying soils of the series, as it is nearer ground water. Its agricultural value is superior to the higher lying soils.

Summit silty clay loam.—The soil to a depth of about 12 to 18 inches is a silty clay loam. It is dark gray in color and becomes black when wet. The soil grades into a mottled yellow, gray, and brown silty clay subsoil. Iron concretions occur at the depth where soil and subsoil merge. The type is of residual origin and derived from shales influenced more or less by thin beds of limestone. The surface is nearly flat and is well suited to tillage operations. The soil is easily cultivated when it contains the proper amount of moisture, but it puddles and bakes if plowed while too wet. Corn, wheat, oats, timothy, and clover give good results.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Summit silty clay loam	Kansas 9; Missouri 10	146,048
Kirkland silty clay loam	Texas 22	52,992
Oswego silty clay loam	Kansas 9	18,688
Crawford silty clay loam	do	7,936
Gasconade silty clay loam	Missouri 11	3,648
Total		229,312

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The residual soils of the clay group in the Great Plains region are moderately extensive. They occur in the northern, middle, and southern States of the region under a range in rainfall from fairly abundant to semiarid and nearly arid conditions. In structure, depth, subsoil or other underlying material, topography, drainage, and relation to agriculture they vary more widely than do the soils of the clay loam group.

Drainage is more frequently inadequate than in the case of the clay loams, though some of the clays have a rolling or broken dissected topography and are subject to excessive surface drainage or to erosion. In general, surface drainage is fairly well established, but percolation and subdrainage is restricted by heavy impervious subsoils. In some of the higher lying and eroded areas the soils are shallow and rock outcrops and stone fragments are encountered. Alkali salts occur in poorly drained depressions or flats in the semiarid districts.

The soil is usually tenacious and refractory, sticky when wet, and puddling and baking upon exposure during dry periods, but with adequate moisture supply and proper drainage and cultivation the clays are usually friable and retentive of water. They demand careful management and thorough tillage and require a heavy farming equipment for economical and effective utilization.

They are adapted only to a heavy type of general farming. Corn, wheat, oats, alfalfa, flax, timothy, clover, and other grass crops, and in the more arid districts kafir, milo, and sorghum are the principal products. Some of the fruits and vegetables can be grown for home use.

The areas which are undeveloped to agriculture because of rough topography, poor drainage, or for other reasons are devoted to grazing.

The soils are used for practically the same purposes as those of the clay loam group. They are, however, adapted to a slightly heavier type of farming, and owing to the unproductiveness of some of the members and to the greater care necessary in their management, this group has a somewhat lower average agricultural value than the clay loams.

Crawford clay.—The soil is a brown or slightly reddish clay 10 inches deep. It is stiff and tenacious when wet, but friable and granular when dry and properly cultivated. The subsoil is a stiff, tenacious clay of a lighter reddish-brown color, which becomes stiffer and more compact with increased depth. Fragments of limestone are often scattered over the surface, and the subsoil sometimes contains white spots caused by partially weathered lime nodules. The type is of residual origin and is derived from the weathering of limestone, which is frequently encountered at a depth of 3 or 4 feet. It occupies gently rolling to rolling upland plateaus, and is naturally well drained. The soil is

adapted to wheat, cotton, corn, and oats, while alfalfa, clover, timothy, rye, and forage crops do well.

Kirkland clay.—The type includes a brown or reddish-brown clay from 6 to 15 inches deep, underlain by a dark-red or reddish-brown heavy clay. It is residual, and is derived from shale and sandstone material. A substratum of red clay shale in encountered at depths ranging from 18 to 36 inches or more. The underlying shale is interbedded with shaly limestone and is sometimes mottled with whitish spots. The topography is rolling to undulating, and the soil is well to excessively drained and subject to erosion. The eroded areas are of little agricultural value. In good seasons fair crops of corn, kafir corn, sorghum, wheat, and alfalfa are grown. The native vegetation consists of prairie grasses.

Leslie clay.—The type is a black heavy clay underlain by a dark-gray or mottled, stiff, compact clay subsoil. This is underlain by bedrock at depths ranging from a few inches to many feet. Both soil and subsoil generally contain fragments of limestone and black fissile shale. During wet weather the soil and subsoil become tough and very sticky, and bake, shrink, and crack on drying. The type is residual, and is derived from the weathering of alternating beds of limestone and black fissile shale. The type occurs in rather intimate association with the Crawford soils. The topography varies from steep to rolling, and the soil in its native state is quite heavily timbered. It is not extensively developed to agriculture, but is adapted to corn, wheat, and oats.

Morton clay.—The soil is a brown clay or silty clay from 6 to 15 inches deep. The subsoil is a gray to light-brown heavy silty clay, which usually passes into drab sandy clay at less than 40 inches. The surface soil is compact, sticky when wet, and puddles and bakes badly. The type occupies small knolls and hillsides, where erosion has in places exposed the fine shales of the Laramie formation from which the soil is derived. The presence of injurious amounts of alkali salts is often indicated in the growth of natural grasses, though cultivated crops are not usually affected. The type is suited to hay, wheat, and flax.

Pierre clay.—The soil consists of a brown tenacious clay, which is compact and impervious. The subsoil is similar in color, texture, and structure. Both soil and subsoil contain large quantities of small light-brown or gray fragments of disintegrated clay concretions. The immediate surface has a whitish or ashy-gray color. The topography is rolling to rough, and surface drainage is good, but percolation and subdrainage is retarded by the compact soil and subsoil material. The soil is residual, and was formed from the Pierre shale. Extreme care is required over most of the type to prevent serious trouble from alkali under irrigation. The type is used mainly for pasture, though small areas are under caltivation. It produces fair crops, and is adapted to grain and hay products.

Summit clay.—The soil to a depth of from 5 to 8 inches is a black, heavy, adhesive silty clay or clay, and is underlain by a yellowish-gray or greenish plastic clay subsoil. The type usually occupies steep slopes and narrow stony ridges. The type is residual, and has been derived from calcareous clay shale which is associated with a thin layer of limestone. Fragments of limestone and chert occur on the surface, and for this reason the type is commonly called "heavy black limestone land." The soil contains a high amount of lime, and drainage is well established. The type is usually timbered. Cultivation is largely confined to the less broken areas. It is a strong, productive soil, and where the surface is not too broken or stony it is well adapted to general farm crops, including corn, wheat, alfalfa, and clover. It is not extensively utilized.

Vernon clay.—This is a red clay to heavy clay loam about 9 inches deep, containing in some localities a small percentage of rounded quartz gravel. The subsoil is a red, heavy, sticky clay, which often contains waterworn gravel from 3 to 4 inches in diameter. This type usually occupies sloping to gullied, eroded areas. It is of residual origin, and is derived from the same shale and sandstone giving the Vernon loam. The soil is used principally for pasture. It is deficient in organic matter and but scantily covered with vegetation.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Crawford clay	Kansas 4; Texas 11, 31	184,384
Pierre clay	South Dakota 1	41,088
Kirkland clay	Kansas 6	40,064
Vernon clay	Oklahoma 1; Texas 30	31,808
Summit clay	Missouri 3	14,976
Morton clay	North Dakota 7; South Dakota 3	9,920
Leslie clay	Missouri 2	1,216
Total		323,456

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

The soils of the stony clay phase of the clay group are represented by the stony clay of the Crawford series.

This soil is widespread and extensive, but owing to its prevailing rough topography, excessive stone content, and shallow depth, it is utilized mainly for grazing and is not widely developed to agriculture. In local areas, where the material is comparatively free from stone and has favorable depth and topography, it is utilized successfully for the production of general farm crops. In some localities the soils are adapted to grapes and tree fruits.

Crawford stony clay.—The soil is dark brown or reddish brown to nearly black. The subsoil is typically reddish brown, but is sometimes a yellow brown. In places the soil material is directly underlain by the bedrock, which generally occurs at shallow depths. Both soil and subsoil usually contain a large quantity of chert and limestone fragments, generally in sufficient amount to interfere with cultivation. The topography is rough and hilly, and rock outcrops frequently occur. The soil is thoroughly dissected by numerous small streams. Drainage is well established and frequently excessive and the soil is rather deficient in moisture-retaining capacity. Owing to its shallow depth, rough topography, and its high stony content, the soil is in general best adapted to pasture, and is usually used for grazing. Small areas on the more moderate and uneroded slopes are utilized to some extent for the production of cotton, corn, wheat, oats, and forage crops. Local areas are well adapted to grapes and orchard crops.

Area and distribution of the stony clay.

Soil name.	State or area.[1]	Acres.
Crawford stony clay	Texas 2, 11, 26, 28, 31	310,144

[1] For key to numbers in this column see p. 733.

GUMBO PHASE.

This phase includes soils which, when classed with respect to texture, properly fall within the clay group, but the areas mapped also include clay loams and silty clay loams. The structure of the soil is such as to render it sticky and tenacious when wet, highly impervious to water, and hard, compact, and refractory when dry. Its structural features are somewhat similar to those of the adobe soils occurring in the western arid and semiarid areas.

A small quantity of alkali is usually present in the soils of the gumbo phase, and probably accounts in part for the intractable character of the soil material.

The phase has been recognized under one soil series and is not extensively developed. Drainage is poorly developed, and the soil is generally utilized only for grazing. It is less important than the clay member of the same series, and can not be used for agriculture until drainage and structural conditions are improved.

Morton gumbo.—While this soil represents a condition rather than a distinct soil type, in general the surface soil is a gray clay loam or clay of silty texture to an average depth of 6 inches. The subsoil is a gray clay loam or clay of

lighter color and higher silt content. The soil is found where the lignite strata and carbonaceous alkali shales which occur through the Laramie formation outcrop. It is residual and is formed from these strata. It is not confined to any particular area of distinct topography, and may occupy sloping hillsides or flat areas. The surface is rough, owing to settling in level areas or to landslides on slopes. Low, stunted cactus, sagebrush, and other alkali and drought resisting plants compose the natural vegetation. The presence of alkali salts and imperfect drainage render the soil unproductive.

Area and distribution of the Gumbo.

Soil name.	State or area.[1]	Acres.
Morton gumbo	North Dakota 7; South Dakota 3	404,736

[1] For key to numbers in this column see p. 733.

GLACIAL MATERIAL.

The soils derived from glacial material do not occur extensively in the Great Plains region. They merely represent small areas of soils which seem to have been derived from an earlier deposit of glacial or ice-laid material and which owing to their location, are included within the Great Plains region rather than the Glacial and Loessial region to the eastward.

The soils are represented by but a single soil series, of which only two members have been recognized. While not relatively important in extent, they are, where not too gravelly, well adapted to agriculture and are esteemed for general farming.

DESCRIPTION OF THE SOIL SERIES.

O'Neill series.—The members of the O'Neill series are essentially dark-gray to brown soils, underlain by light-brown subsoils resting upon sand and gravel. The topography varies from nearly level to very rough and broken. The series is derived by weathering from a bed of glacial drift which underlies the loess. The surface is usually modified by wind-blown materials. The deeper loamy members of the series have a high value for general farming and are adapted to small grains, corn, potatoes, forage crops, etc.

Area and distribution of the soils of the O'Neill series.

Soil name.	State or area.[1]	Acres.
O'Neill loam	Nebraska 7	138,240
gravelly loam	do	211,968
Total		350,208

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

LOAM GROUP.

The Great Plains region embraces comparatively little soil derived predominantly from glacial material, and, so far as recognized, this is confined to a single soil series and to the loam group with one phase.

The loam occupies gullied or dissected areas and has a deep subsoil, which occurs at comparatively shallow depths and consists of porous sands and gravels. This underlying material, with the prevailing topography, favors ready surface drainage and subdrainage, so that the soil is somewhat better drained and earlier than the average soils of the loam group occurring in the other provinces within the region. The soil is friable and mellow and is retentive of moisture under tillage. It requires only moderately heavy farming equipment and is well adapted to general farming and to potatoes.

O'Neill loam.—The soil is dark gray to brown and has an average depth of about 10 inches. The upper subsoil is light yellowish-brown, compact, and somewhat heavier than the soil material. At an average depth of about 24 inches a deeper subsoil, consisting of a porous mass of sand and gravel, is encountered. The topography is generally undulating, but the soil areas include dissected or gullied slopes along stream channels. The type is derived mainly from glacial drift, but the superficial material probably includes later wind-laid material or alluvial deposits of minor streams or sheet erosion. The type is friable and retentive of moisture, but is well drained. It is adapted to corn, small grains, and potatoes, and in local areas to alfalfa.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
O'Neill loam	Nebraska 7	138,240

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase is similar in origin and in general topography to the loam soil occurring under this series and province. It departs from the loam in the more shallow depths at which the underlying porous sands and gravels are encountered and in the more gravelly and coarser nature of the soil material. Surface drainage and subdrainage are excessive and the soil is not retentive of moisture and is subject to drought during periods of deficient rainfall. It is for this reason of subordinate importance in agriculture and is utilized mainly for grazing.

O'Neill gravelly loam.—The soil is dark gray or brown and prevailingly of loam or sandy loam texture. It is underlain at shallow depths by a stratum of coarse sand and gravel, with but little interstitial material. The topography ranges from comparatively level or undulating in eroded areas to dissected and hilly in the vicinity of streams. The type is derived predominantly from glacial outwash material, but the superficial soil is probably in part of wind-laid origin. It is utilized mainly for grazing, to which it is well adapted. Drainage is excessive and, owing to scanty rainfall, the type is not well adapted to farm crops.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
O'Neill gravelly loam	Nebraska 7	211,968

[1] For key to number in this column see p. 733.

LAKE-LAID MATERIAL.

The soils derived from lacustrine or lake-laid material are of local occurrence. They are represented by the members of the Randall, Scott, and Hoisington series, which cover comparatively inextensive areas. Only one or two members of each of these series have been encountered in this province and these are soils of heavy texture. The material was derived through the erosion of fine soil material and its deposition in shallow waters of depressions or of ponded drainage courses.

The soils of this province are usually deep, and where well drained and properly cultivated are productive and adapted to general farming. They are naturally poorly drained, however, and in most cases artificial drainage is difficult and expensive. Even these wet areas are of some value for grazing and for the production of wild hay.

DESCRIPTION OF THE SOIL SERIES.

Hoisington series.—The soils of this series are dark brown or dark drab and usually black when wet. They are predominantly compact and become sticky when wet, readily puddling, and baking upon exposure. The subsoils are dark drab in color and usually heavy and compact. The material is derived from adjoining soils originating from sandstone, shale, and limestone, and has been deposited by intermittent streams or sheet waters in shallow lakes occupying undrained, sinklike depressions in upland plains. A large part of the type is submerged during rainy periods. Where free from overflow and capable of cultivation the soil is productive. It is adapted to corn and forage crops, such as kafir and sorghum.

Area and distribution of the soil of the Hoisington series.

Soil name.	State or area.[1]	Acres.
Hoisington undifferentiated	Kansas 10	39,168

[1] For key to number in this column see p. 733.

Randall series.—The soils of the Randall series are dark drab to black. The subsoils are usually drab or dark gray. The soils of this series consist of lake-laid sediments washed from more elevated soils derived from unconsolidated Tertiary deposits. They occur in shallow depressions in upland plains, which are occupied during rainy periods by temporary lakes or ponds. They are entirely without natural drainage, are subject to periodical inundation, and are barren of vegetation. Artificial drainage is impracticable, and the areas are not agriculturally important.

Area and distribution of the soil of the Randall series.

Soil name.	State or area.[1]	Acres.
Randall clay[2]	Texas 22	

[1] For key to number in this column see p. 733.
[2] This soil was encountered only in reconnoissance work in areas too small to map on the scale used.

Scott series.—The soils are dark brown to drab. The subsoils are lighter drab or brown. The members of the series consist of lake-laid material eroded from higher-lying loessial soils and deposited by sheet surface waters or intermittent streams in the shallow waters of temporary lakes or ponds occupying local, undrained, sinklike depressions in upland plains. The soils are frequently heavy and refractory and are poorly drained. They are subject to periodical submergence. Where not subject to overflow and where sufficiently well drained, they are productive and are adapted to corn, small grains, alfalfa, and forage crops.

Area and distribution of the soils of the Scott series.

Soil name.	State or area.[1]	Acres.
Scott silt loam	Kansas 10	6,912
silty clay loam	do	62,208
Total		69,120

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SILT LOAM GROUP.

The lacustrine or lake-laid sediments of the Great Plains region, so far as encountered by the soil survey, are soils of fine texture. The coarser material has a silt loam texture, and is included in a single soil series, represented only by the silt loam group with one phase.

In general the silt loam soils are well drained, but in some areas drainage is inadequate, and owing to their location some of the better-drained areas suffer from insufficient rainfall. With respect to utilization, the silt loam is comparable with the soils of similar texture in other provinces in the region. The soil requires a rather heavy farming equipment and careful management. It is adapted to a heavy type of general farming, and is best suited to the production of grain and hay.

Scott silt loam.—The soil is a dark-brown to drab silt loam, 12 inches deep. The subsoil from 12 to 24 inches is a light-drab, smooth, slightly coherent silt loam, underlain to 36 inches by a light-gray silt loam which is very incoherent when dry. The type is mainly of lacustrine origin, being deposited from shallow waters standing over or flowing into depressions. The material is derived from erosion of loessial soils by intermittent streams or surface waters during rains. The type usually occupies gentle slopes and is fairly well drained. In places small amounts of alkali salts accumulate. Where the rainfall is adequate the soil is adapted to wheat and corn, and these constitute the principal crops.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Scott silt loam	Kansas 10	6,912

[1] For key to number in this column see p. 733.

CLAY LOAM GROUP.

SILTY CLAY LOAM PHASE.

The silty clay loam of the province differs from the silt loam soil in having a finer, heavier, and more compact surface soil and a heavier and more impervious subsoil. Its drainage is less well developed. The silty clay loam and silt loam are included in the same series.

The soil is colder and later, and requires a heavier farming equipment and more careful management and thorough tillage than the silt loam. It is utilized mainly for the production of corn and alfalfa, and is well adapted to the cereal and hay crops.

Scott silty clay loam.—The soil is a dark-brown to drab silty clay loam 12 to 16 inches deep. It is rather compact and refractory, but under cultivation it is fairly friable. It is underlain by a silty clay loam to a depth of 30 to 32 inches. The subsoil gradually becomes lighter in color as its depth increases, and below 32 inches it changes to a silty clay mottled with calcareous material. The subsoil is hard and brittle when dry, but plastic when moist. The type is of lacustrine origin. The parent material is derived from erosion of more elevated areas of loessial soils by surface waters or intermittent streams, and deposited in the shallow waters of temporary lakes in local depressions. Where not subject to flooding the soil is very productive, corn and alfalfa being the principal crops.

Area and distribution of the silty clay loam.

Soil name.	State or area.[1]	Acres.
Scott silty clay loam	Kansas 10	62,208

[1] For key to number in this column see p. 733.

Clay Group.

The lake-laid soils of the clay group in the Great Plains region are not extensive and are comparatively local in occurrence.

The soils are compact and refractory, and the soil and subsoil material is relatively impervious. Surface drainage is prevailingly deficient. The soils generally occupy local depressions, and a great part of the area covered is subject to inundation by shallow waters during rainy periods.

They are productive where drained, carefully managed, and thoroughly cultivated, but artificial drainage is generally impracticable.

The soils are not generally adapted to agriculture, and are capable of utilization only for grazing or the production of wild hay of low value.

Randall clay.[1]—This type is a dark-drab or black clay having a depth of 36 inches or more. The surface 8 to 12 inches is slightly darker in color than the subsoil, owing to a greater content of organic matter. The soil is heavy and sticky. It becomes hard and sometimes cracks to depths of several feet. It is without drainage. The type occupies the bottoms of small depressions, which during rainy periods are occupied by intermittent or temporary lakes. The soil has been formed by the washing of finer material from the higher surrounding Tertiary deposits. The soil is productive, but owing to inadequate drainage it is rarely cultivated, except around the higher outer edges.

WIND-LAID MATERIAL.

In the prairies and plains the winds attain a higher velocity and follow a more constant direction than in forested areas or regions of greater variation in topography, and are more effective as an agency in the transportation of soil material and the formation of soils.

While practically all of the lighter soils of the region, where not protected by vegetation or topography, are more or less modified by drifting, the typical soils of the wind-laid province are most extensively developed in or near the central part of the Great Plains region. The wind-laid soils constitute one of the smaller provinces of the region, but they are extensive and are important in agriculture.

A large part of the parent material consists of loessial deposits associated with the soils of the Glacial and Loessial province on the east. These loessial deposits are of somewhat doubtful geologic origin, but are supposed to have been formed by eolian agencies. They are generally of fine texture, friable, and productive. These loessial deposits are frequently so similar to the soils of the residual or other provinces that their separation is difficult. They formerly covered larger areas in the Great Plains region, but were reduced in extent by erosion or other agencies, and from the remaining areas of these old loessial deposits the more important of the wind-laid soils, including the Derby, Finney, and Colby series, have been derived. These soils, which include sandy loams, fine sandy loams, loams, and silty loams, are usually retentive of moisture and are well adapted to agriculture both with and without irrigation. They occur in districts of undulating to rolling topography. Local areas are dissected and broken where eroded by streams. With the exception of the rougher areas, which are utilized for grazing, they are devoted to the production of corn, small grains, and forage crops.

In some localities remnants of the uneroded loessial material have become intermingled with residual material derived from the weathering in place of calcareous conglomerate of the Tertiary Mortar Beds. This has given rise to the soils of the Canyon series, which is represented by a single member, usually of eroded broken topography, and of importance mainly for grazing.

In other places areas of soil material blown from recent alluvial deposits in stream valleys are encountered. Such soil areas may be of local or of extensive occurrence. Conditions are most favorable to accumulation of the soil material on the side of wide stream valleys opposite to the direction of the wind. The soils are most extensive where the valleys are entrenched but little below the level of the plain and are traversed by wide, shallow, shifting streams, in which wide areas of sand bars or of recent flood-plain deposits unprotected by vegetation are exposed during periods of low water. Such soils are represented by the Smithwick series. These have an undulating or dunelike topography, are

[1] Encountered only as small local depressions in the areas of Amarillo silty clay loam in the reconnoissance survey of the Panhandle region of Texas, and not separately mapped.

usually excessively drained, and are subject to surface drifting. The series is represented by the fine sand and the sandy loam types, which are successfully utilized for general farming in good seasons.

In other districts of the Great Plains occur extensive areas of wind-laid soils derived from sandy material of the unconsolidated fluviatile Tertiary deposits. These deposits are represented by the soils of the Valentine series, which so far as encountered are soils of light texture.

DESCRIPTION OF THE SOIL SERIES.

Canyon series.—The soils of the Canyon series are light brown or ashy brown, and the subsoils are yellowish gray. Both soil and subsoil usually contain fragments of disintegrated soft calcareous conglomerate of the Tertiary Mortar Beds. The members of the series are mainly derived from loessial material but contain residual material from soft calcareous conglomerates, sands, and finer deposits of the Tertiary formations. The topography is hilly and eroded, and the greater part of the areas covered by the series is suitable only for grazing. Where locally capable of cultivation the soils are best adapted to corn and to such forage crops as kafir, milo, and sorghum.

Area and distribution of the soil of the Canyon series.

Soil name.	State or area.[1]	Acres.
Canyon loam	Kansas 10; Nebraska 7	792,576

[1] For key to numbers in this column see p. 733.

Colby series.—The soils are ashy gray or brownish gray. The upper subsoil is of similar or slightly lighter color and of heavier texture and compact structure and is 2 to 8 inches thick. The deeper subsoil is a light-yellowish or yellowish-brown silt loam of mealy consistency and friable character. The members of the series are of wind-laid origin and are derived from loessial deposits. The surface portion, comprising the soil and upper subsoil material, has been considerably weathered. The topography is comparatively level to sharply rolling. The soils are well drained and are well adapted to general farm crops with favorable climate. Wheat, corn, and forage crops are the principal products.

Area and distribution of the soil of the Colby series.

Soil name.	State or area.[1]	Acres.
Colby silt loam	Kansas 10; Nebraska 1[2], 7	16,679,424

[1] For key to numbers in this column see p. 733.
[2] The part of the area not covered by the reconnoissance survey.

Derby series.—The soils of this series are yellowish brown to reddish brown and are underlain by reddish-brown subsoils, which in the lighter members are somewhat heavier and more compact than the soil material. The members of the series are of wind-laid origin and are derived from loessial deposits. They occur in rolling upland prairie regions and are well drained. They are well adapted to grains and other staple farm crops of the region in which they occur, and are utilized mainly for the production of corn and wheat.

Area and distribution of the soil of the Derby series.

Soil name.	State or area.[1]	Acres.
Derby loam	Kansas 11	20,416

[1] For key to number in this column see p. 733.

Finney series.—The soils range in depth from a few inches to several feet, and vary in color from light brown to nearly black. The subsoils are lighter brown. The topography varies from nearly level to rolling and rough, and excepting in some small, depressed areas both surface and underdrainage are well developed. The soils are sometimes subject to erosion. They are mainly of wind-laid origin and are derived from loessial material. This may be in the form in which it was originally deposited or it may be subsequently modified by eolian action. Locally it may include material washed from higher areas into small depressions. The heavier soils of the series can be dry farmed to advantage and would be improved by irrigation. They are utilized mainly for the production of corn, small grains, alfalfa, and clover. The lighter soils have a broken topography. They are open and porous and are easily drifted. They are best adapted to grazing.

Area and distribution of the soils of the Finney series.

Soil name.	State or area.[1]	Acres.
Finney sandy loam	Kansas 3	6,272
fine sandy loam	Nebraska 4	40,128
loam	do	11,008
Total		57,408

[1] For key to numbers in this column see p. 733.

Smithwick series.—The soils of the Smithwick series are light brown or grayish brown to yellowish brown. The subsoils are yellowish brown. The series consists of wind-laid material, generally blown from alluvial soils of light texture occupying wide sandy bottoms and terraces in stream valleys, and derived from crystalline rocks with some admixture of material from sedimentary rocks and from unconsolidated Tertiary deposits occupying stream outwash plains. The members of the series occupy areas of undulating to hillocky or dunelike topography. They are somewhat subject to drifting and are usually excessively drained, but are fairly retentive of moisture, and are adapted to melons, cantaloupes, and truck crops. Corn, sorghum, kafir, and vegetables are the principal products.

Area and distribution of the soils of the Smithwick series.

Soil name.	State or area.[1]	Acres.
Smithwick fine sand	Kansas 6	23,104
sandy loam	South Dakota 3	69,120
Total		92,224

[1] For key to numbers in this column see p. 733.

Valentine series.—The Valentine series consists of brown to dark-brown soils. In the loamier members the soils are slightly sticky. The subsoils are light brown to brown and usually heavy. Below 3 feet they grade into loose sands. The members of this series consist of wind-laid material derived mainly from the sandy strata of the stream outwash plain deposits of Tertiary age, and are associated with Dunesand. They occupy level, terracelike areas along the streams and valleys and basins in the sand-hill regions. In some places the material has been modified by alluvial agencies. The topography ranges from almost level flats to dune-shaped hills. The members of the series are usually well drained, and in outlying areas the water table is encountered near the surface. The soils are adapted to corn, potatoes, truck, forage, and hay crops. Small grains are grown to a limited extent.

Area and distribution of the soils of the Valentine series.

Soil name.	State or area.[1]	Acres.
Valentine sand	Nebraska 7	154,368
loamy sand	do	177,408
fine sandy loam	do	725,760
Total		1,057,536

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The soils of the sand group of the Wind-laid province have been recognized under but one series. The surface material of this type is more compact and loamy than the average sands. The deeper subsoil is incoherent and is not retentive of moisture. The soil is subject to some variation in topography and drainage. It is usually well drained, and in higher areas of undulating topography drainage is excessive. In low-lying depressions surface drainage is poor and the water table occurs at shallow depths. The soil occurs in regions of light rainfall, and exposed areas are subject to wind blowing.

The soil is generally used for grazing and the production of wild hay, which is grown in the lower lying areas, where drainage is poor. It is naturally adapted to truck crops, melons, etc., but poor drainage, inadequate moisture supply, and the lack of transportation facilities and markets prohibit its use for these purposes. Corn, alfalfa, and other general farm and forage crops can be grown in areas where moisture conditions are favorable, the general adaptability of the soil to agriculture being somewhat higher under such conditions than is that of the sand types in general.

Valentine sand.—The soil is a brown to dark-brown medium to fine sand, which usually extends to a depth of 6 to 12 inches. The subsoil is light brown in color and similar to the soil in texture, becoming yellowish and loose and incoherent below 36 inches. The soil and upper subsoil material is moderately sticky when wet. The topography is comparatively level to undulating, and the surface is occasionally broken by small ridges or dunes of wind-blown sand. Level flats, which have the appearance of terraces, lie between the sand hills and the lower lying soil areas. The material is derived from unconsolidated Tertiary deposits laid down as outwash plains and subsequently modified and transported by winds. The type is usually well drained, but in lower lying areas the water table is near the surface. The soil is friable, easily tilled, and is utilized mainly for the production of wild hay. Corn is grown to a limited extent with fair results, and with sufficient moisture and well-developed subdrainage the type is adapted to alfalfa.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Valentine sand	Nebraska 7	154,368

[1] For key to number in this column see p. 733.

LOAMY SAND PHASE.

The loamy sand is in this province confined to a single soil series. It differs from the sand of the same series in having a slightly more loamy texture and greater water-holding capacity. Drainage is less rapid than in the sands. It occupies low-lying flats or depressed areas. The soil is friable and requires only a light farming equipment. It is superior to the sand of the province for farming and is devoted mainly to forage crops and general farming and to the production of potatoes. Poorly drained areas, which occur locally, are devoted to

grazing or to the production of wild hay. With good markets and transportation facilities melons and early truck crops could be produced successfully.

Valentine loamy sand.—The soil is brown to dark grayish brown, and the subsoil is lighter brown in color and of somewhat lighter texture and more porous structure, becoming loose and incoherent in the deeper section. The type is derived from unconsolidated or loosely consolidated stream outwash plain deposits of the Tertiary formations, subsequently modified and transported by winds. It occupies depressed basins or flats in the sand-hill districts, or comparatively level terracelike areas in stream valleys. It is devoted mainly to the production of corn, forage crops, and potatoes, and in the depressed areas is extensively used for wild hay.

Area and distribution of the loamy sand.

Soil name.	State or area.[1]	Acres.
Valentine loamy sand	Nebraska 7	177,408

[1] For key to number in this column see p. 733.

Fine Sand Group.

The fine sand of the Eolian or wind-laid province of the Great Plains region has been encountered only under one soil series.

In this case the topography ranges from gently undulating to hillocky and wind blown. The soil and subsoil are loose, porous, and leachy, and are naturally deficient in moisture-holding capacity. When cultivated or denuded of native vegetation the type is subject to destructive drifting. The soil is easily maintained in good tilth, and where protected from winds and intensively cultivated is moderately retentive of moisture. Areas of good location and sufficient rainfall are devoted to some extent to the production of corn, kafir, sorghum, and vegetables, the yields usually being light. The type requires but light farming equipment. Where supplied with sufficient moisture and capable of irrigation, and with good markets and transportation facilities, melons, cantaloupes, and early truck crops can be profitably grown. The type has a lower agricultural value than the loamy sands of the province.

Smithwick fine sand.—The Smithwick fine sand is a gray to brownish-gray or light-brown fine sand, 8 to 15 inches in depth, underlain by a brown or yellow fine sand, extending to depths of from 3 to several feet. The topography is undulating to hillocky and dunelike, the materal having been transported and left in its present condition by winds. The soil is derived mainly from stream outwash plain or alluvial soils of light texture, occupying stream valleys, and derived mainly from crystalline rocks, but to some extent from sedimentary rocks. When not protected by vegetation the type is subject to blowing, so that great care is necessary in its cultivation. Drainage is excessive, though where a surface mulch is maintained the soils hold sufficient moisture for the production of light yields of corn, kafir, sorghum, and vegetables. The type is probably best suited to vegetables, melons, cantaloupes, etc.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Smithwick fine sand	Kansas 6	23,104

[1] For key to number in this column see p. 733.

Sandy Loam Group.

The sandy loam soils derived from wind-laid material in the Great Plains region have been encountered under two soil series.

There is some variation between these two members of the group in topography and in the underlying material. In general the topography is undulating or rolling, but in places the surface is quite hilly. Dunelike undulations com-

monly occur. The surface material is loamy and fairly retentive of moisture, and it does not drift to any great extent under judicious management, except in more exposed situations. Drainage is well established.

The soils are devoted mainly to grazing and to the cultivation of corn, wheat, oats, sorghum, and alfalfa. They are superior to the lighter-textured soils of the province for general farming, but with ample moisture supply, favorable transportation conditions, and good markets they are somewhat better adapted to melons, potatoes, early tomatoes, and other early truck crops than to the general farm crops. They require but a light and inexpensive farming equipment, and are mellow and friable under cultivation.

Finney sandy loam.—The soil is a light-brown to dark-brown medium to fine sandy loam, ranging in depth from a few inches to several feet. This is always underlain by a light-brown or brown silt loam, which is sometimes quite heavy and usually extends to a great depth. The type is formed largely of wind-blown sandy material overlying loessial deposits or the Plains marl of unconsolidated Tertiary deposits. The superficial material is derived from drifting-sand areas or from sandy Tertiary deposits. The same form of weathering has affected the texture of the soil, which contains a high percentage of clay and silt. It is free from alkali, but the subsoil contains a large amount of lime. The surface is generally rolling, especially in upland areas. Drainage is well developed, and by reason of the heavy subsoil it is retentive of moisture. Sorghum and alfalfa are the principal crops. A great part of the type is used for grazing.

Smithwick sandy loam.—This soil to a depth of 8 to 12 inches is a brown sandy loam and is underlain by a yellow or yellowish-brown sandy loam having a slightly reddish tinge. Below 24 to 30 inches the subsoil is lighter in color and in texture and consists of a loamy sand. Enough silt and clay are present to give the soil a loamy character. This fine material renders the soil coherent, so that the material will stand as firmly in banks as heavier soils. It is derived from wind-blown material, mainly from crystalline rocks, but includes some material from sedimentary rocks, transported along stream bottoms in broad river valleys. This material has not usually been moved far by winds. The surface is rolling to hilly and in most cases dunelike. Corn, wheat, and oats are grown, and fair yields are secured. It is a good truck and melon soil, and tomatoes, watermelons, and potatoes have been grown with much success.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Smithwick sandy loam	South Dakota 3	69,120
Finney sandy loam	Kansas 3	6,272
Total		75,392

[1] For key to numbers in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loams of this province have been recognized under two soil series.

These two members differ widely in topography and in drainage. One has a rough, broken, and eroded topography with excessive drainage, while in the other the surface is comparatively flat to gently rolling and eroded only in the vicinity of stream channels.

The soil and subsoil readily absorb surface waters, and where drainage is not excessive they are retentive of moisture under cultivation. The rougher and more excessively drained and easily eroded areas are not suitable for agriculture and are best adapted to grazing. With suitable topography and moderate drainage the fine sandy loams are slightly superior to the sandy loam soils for general farming. The soil is, however, best adapted to a rather light type of farming and is also suited to the production of moderately early truck crops. Corn, potatoes, small grains, and forage crops are the principal products.

Finney fine sandy loam.—The soil consists of very light brown to grayish-brown fine sandy loam from 6 to 10 inches deep. The subsoil has practically the same texture, but a lower humus content, which gives it a lighter color.

The type occupies bluffs and areas of rough, broken topography which, with the loose, porous structure of the material, permits thorough drainage. It is of wind-laid origin, is derived from loess deposits, and erodes readily. The type occurs mainly as grass-covered prairie and is used for pasture, being too droughty for extensive agriculture.

Valentine fine sandy loam.—The soil is a light-brown fine sandy loam with an average depth of 14 inches. The subsoil is lighter brown in color and usually a sandy loam in texture. The type occupies comparatively level to gently rolling areas, and in the vicinity of streams the soil bodies are frequently dissected and eroded. The more level areas occur along terracelike flats in stream valleys. The material is derived from unconsolidated, sandy Tertiary deposits distributed as stream outwash plain material which has been subsequently wind blown. It is composed mainly of feldspar and other minerals from crystalline rocks which have been modified subsequent to their deposition by weathering in place. The type is productive, readily absorbs surface waters, and is well adapted to vegetables and truck. Corn, potatoes, and forage crops are the principal products. Wheat and oats are grown to some extent.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Valentine fine sandy loam	Nebraska 7	725,760
Finney fine sandy loam	Nebraska 4	40,128
Total		765,888

[1] For key to numbers in this column see p. 733.

Loam Group.

The soils of the loam group predominate in the comparatively inextensive Wind-laid province of the Great Plains region. They have been mapped under three soil series.

Two members of the group occupy areas of comparatively level or gently rolling topography and are underlain by moderately heavy, but not impervious, subsoils. They are retentive of moisture under cultivation, but naturally somewhat droughty, owing to light rainfall. Drainage is well established and but few areas are subject to erosion. The other member of the group has a hilly and eroded topography. Surface drainage is excessive and the rainfall is inadequate.

The areas of rough topography and deficient moisture supply are utilized mainly for grazing, although corn and the more drought-resistant crops, such as kafir, milo, and sorghum, are grown with fair success in favorable seasons on local areas suitable for cultivation. The more typical areas, where favorably located with respect to climate and topography, are devoted mainly to the production of corn, wheat, oats, and hay.

The soil is friable and retentive of moisture under cultivation. It is best adapted to a moderately heavy type of general farming and requires a rather heavy farming equipment for efficient and economical management.

The group as a whole is superior to the soils of the preceding groups of the province in moisture-retaining capacity and in adaptability to general farming.

Canyon loam.—The typical soil is an ashy-brown loam of silty texture carrying a high percentage of fine sand. The subsoil to a depth of more than 36 inches is a yellowish-gray silt loam. Fragments of the calcareous conglomerate, known as Mortar Beds, are scattered through both soil and subsoil. The topography is always hilly and the greater part of the type is too rough to farm. The material is derived mainly from wind-laid loessial deposits, but both soil and subsoil include residual material from the soft calcareous conglomerates, sands, and finer Tertiary deposits. The type is used mainly for pasture. Corn, kafir, and milo are the most profitable crops.

Derby loam.—This type is a mellow, yellowish-brown to reddish-brown silty loam 10 inches deep, grading almost imperceptibly into a reddish-brown heavy and compact silty loam subsoil. The type is of wind-laid origin and derived from loessial material. It occupies rolling upland prairie and is well drained.

Corn and wheat are the principal crops, corn yielding about 25 bushels and wheat 18 bushels per acre.

Finney loam.—The surface soil is a brown loam of silty or very fine sandy texture with an average depth of 14 inches. The subsoil is a grayish-brown or yellowish-brown to chocolate colored heavy silty loam or light clay loam, becoming lighter in texture at depths of 24 to 30 inches. The type is locally known as "hard land." It occupies level to gently rolling uplands. Drainage is well established, and the type generally free from erosion. The material is of wind-laid origin and derived from loess. A heavy growth of grasses has provided a large amount of organic matter, making the soil very productive and well adapted to a large variety of crops. Corn, wheat, oats, alfalfa, clover, broom grass, and fescue do well, although the crops are frequently injured by droughts. Corn and wheat are the principal crops grown.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Canyon loam	Kansas 10; Nebraska 7	792,576
Derby loam	Kansas 11	20,416
Finney loam	Nebraska 4	11,008
Total		824,000

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

The silt loam group in this province has been recognized under but one soil series, which is represented only by the silt loam type. It is, however, of widespread and extensive occurrence in the central part of the Great Plains region.

The soil is rather compact and slightly inclined to puddle when wet and to bake when exposed during dry periods. It is friable under cultivation and is readily maintained in a mellow condition. A rather heavy farming equipment is required for its effective cultivation. The topography and drainage vary somewhat, but the surface contour is generally such as to permit the use of farm machinery.

The soil is not subject to wind drifting and is retentive of moisture. It is adapted to a rather heavy type of general farming where moisture conditions are favorable. Rainfall is usually deficient in the more western areas. Corn, wheat, and forage crops, including sorghum, kafir, and related products, are the principal crops. Under similar conditions of climate and topography the soil is closely allied with members of the loam group in its relation to agriculture, but it is somewhat better adapted to a heavy type of general farming.

Colby silt loam.—The soil is an ashy-gray to brownish-gray silt loam with a small content of fine sand and clay, ranging in depth from 6 to 24 inches. It has a compact structure, and under favorable moisture conditions the type is friable and easily cultivated. The upper layer of the subsoil, varying from 2 to 8 inches in thickness, is a compact silty clay loam or clay. This is underlain to a depth of more than 3 feet by a light-yellow or yellowish-brown silt loam having a smooth mealy feel characteristic of the unweathered loess. The topography ranges from almost level to sharply rolling. The type is of wind-laid origin and is derived from the weathering of loess, and the thickness of the two upper zones represent the extent of this process. The lower subsoil is loess which is but little altered. The type is retentive of moisture and is adapted to the general farm crops. Wheat, corn, sorghum, kafir, and other forage crops are extensively grown.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Colby silt loam	Kansas 10; Nebraska 1, 7	16,679,424

[1] For key to numbers in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The alluvial fan and valley-filling soils have been derived from the great areas of Tertiary deposits, with those less extensive areas of local alluvial fan and foot-slope material. These deposits are typically unconsolidated, but include certain zones or belts of material which is usually calcareous and more or less indurated or cemented.

A large part of the Tertiary deposits is composed predominantly of fragments of quartz and feldspar which have in places undergone weathering. The feldspar often imparts a reddish tint to the soil and subsoil. In many cases these have been washed into and concentrated in the subsoil material, giving rise to a group of soils marked by subsoils of higher clay content and more compact structure than the surface material. The lower portions of the Tertiary deposits are often highly calcareous, and some of the soil types are marked by the presence of this calcareous material in the subsoil.

The soils derived from the deeper deposits of the quartz-bearing crystalline rocks are represented in the Colorado and Pratt series, which occur extensively in the western parts of the Great Plains. Those soils which are derived from calcareous deposits or are underlain at shallow depths by calcareous beds are included in the Fowler, Greensburg, and Richfield series. Some of the weathered deposits of the Tertiary beds are loose and porous, and where encountered within the soil section have given rise to porous, leachy subsoils such as those of the Albion series.

Small areas of soil encountered in the east-central part of the Great Plains region, outside the region of Tertiary deposits, consist of local alluvial fan or foot-slope material. These soils are associated in origin with the soils already mentioned. Some are characterized by a substratum of granitic bedrock, the subsoil being in part residual, and are included under the Tishomingo series. Others are distinguished by the occurrence of chert fragments and by a hardpan substratum, and are represented by the soils of the Lebanon series.

Some of the soils of the outwash plain province include material derived from both quartz-bearing crystalline and from sedimentary rocks, the material of the sedimentary rocks usually predominating. Material of this character is represented in several series of soils, including the Rosebud, Zapata, Amarillo, and Orella.

In other areas of the plains the soil material is apparently derived from sedimentary rocks only slightly modified by material from other sources. Some of the soils are derived from shale and sandstone, and are represented by the Sedgwick and Dawes series; others are from sandstone and limestone, and are included in the Ashland series; while others of recent formation are derived from shale alone, and are classed in the Orman series.

There are also included within this province local areas of soils that consist of recent fan and foot-slope deposits derived from erosion of wind-laid deposits. These are represented by the Gannett series.

The soils of the Outwash Plain province are generally well drained, of good depth, and have a gently undulating to sloping or nearly level topography which is favorable to the extensive use of farming machinery. In the larger areas, however, crop yields are dependent upon an uncertain and often poorly distributed moisture supply. Under favorable conditions of rainfall the soils are productive and well adapted to farming, and where capable of irrigation they can be used for a wide range of general farm crops and intensively cultivated products.

By far the greater part of the soil areas, however, can not be extensively irrigated, owing to limited water supply. Extensive areas in the more arid districts are profitably utilized for grazing in connection with stock raising, and some of the soils capable of being utilized for farming are more profitably used for grazing, owing to lack of facilities for shipping farm products.

DESCRIPTION OF THE SOIL SERIES.

Albion series.—The soils are brown to dark brown, with dark reddish brown subsoils. The series is related to the Pratt, differing principally in the larger amount of gravel in the subsoils, which tends to make the soils porous, leachy, and droughty. The soil material of this series is derived from the more gravelly phases of unconsolidated Tertiary deposits, consisting mainly of crystalline rocks and distributed as outwash plain or extensive alluvial foot

slopes by shifting aggrading streams. The topography is undulating to rolling, and the soils are well drained. Their agricultural value is somewhat lower than that of the Pratt soils. Corn, forage crops, wheat, and alfalfa are the principal crops.

Area and distribution of the soils of the Albion series.

Soil name.	State or area.[1]	Acres.
Albion loamy coarse sand	Kansas 6	11,968
sandy loam	do	89,984
loam	do	48,384
Total		150,336

[1] For key to number in this column see p. 733.

Amarillo series.—The Amarillo series includes chocolate-brown to reddish-brown soils with brown to reddish-brown subsoils. The subsoil grades into a substratum of white or pinkish-white calcareous material usually within 3 feet of the surface, which constitutes a characteristic feature of the series. The topography ranges from nearly level or undulating to rolling and sometimes broken. The soils are formed from unconsolidated Tertiary and Quaternary deposits derived from sandstone, shale, limestone, and crystalline rocks, and distributed by former aggrading streams as mountain foot slope, alluvial fan, or stream outwash plains material. The sandy members have subsequently been modified by wind action. Under favorable moisture conditions these soils are well adapted to general farm crops.

Area and distribution of the soils of the Amarillo series.

Soil name.	State or area.[1]	Acres.
Amarillo loam	Texas 22	1,294,848
silty clay loam	Texas 22[2]	6,324,480
undifferentiated	Kansas 10; Texas 22	4,140,288
Total		11,759,616

[1] For key to numbers in this column see p. 733.
[2] Includes some small areas of Randall clay.

Ashland series.—The soils are light brown to dark brown, and are underlain by yellowish-brown to dark-brown subsoils, frequently marked by streaks or mottlings of calcareous material. The soil material consists of local alluvial outwash deposits, derived from sandstone, shale, and limestone rocks of Tertiary age, and distributed as alluvial fan or alluvial slope deposits by intermittent streams or surface sheet waters. The soils occupy terracelike areas in valleys formed in part by the removal of the underlying material by solution. The soils are usually well drained and adapted to the general farm crops of the region. Wheat, corn, and forage crops are the principal products.

Area and distribution of the soils of the Ashland series.

Soil name.	State or area.[1]	Acres.
Ashland silt loam	Kansas 10	13,824

[1] For key to number in this column see p. 733.

Colorado series.—The soils are of gray to reddish-brown color and contain fine quartz and feldspar fragments. The subsoils are reddish brown and similar to the soil in mineral characteristics. They are generally heavier than the overlying material and noticeably more compact, becoming sticky when wet. The series is derived from unconsolidated Tertiary deposits, which were derived from Pre-Cambrian crystalline granite rocks and distributed as low, broad foot

slopes and alluvial fan by aggrading, shifting streams. These deposits were subsequently weathered in place, and the decomposition of the feldspathic material has given rise to sticky, compact subsoils. In some areas a substratum of sedimentary rock occurs, but at depths of 6 to many feet. The members of the series occupy remnants of the High Plains or uneroded, gently sloping, plateau-like areas interrupted by the low, broad valleys of the larger rivers or by the deep, narrow valleys of intermittent streams. They are treeless, usually well drained, and retentive of moisture. The lighter members are wind blown. Where capable of irrigation the soils are adapted to vegetables, tree fruits, alfalfa, melons, and some of the members to sugar beets.

Area and distribution of the soils of the Colorado series.

Soil name.	State or area.[1]	Acres.
Colorado sand	Colorado 2, 3	128,576
sandy loam	Colorado 3	156,096
gravelly loam	Colorado 2	33,408
clay loam	Colorado 3	832
Total		318,912

[1] For key to numbers in this column see p. 733.

Dawes series.—The soils are ashy gray to light brown in color, with white to pinkish-white subsoils. The material is derived from alluvial fan or outwash plain deposits formed mainly from the weathering of Tertiary sandstone and shale. The topography is moderately rolling to sloping.

Area and distribution of the soil of the Dawes series.

Soil name.	State or area.[1]	Acres.
Dawes undifferentiated	Nebraska 7	317,952

[1] For key to number in this column see p. 733.

Fowler series.—The series has dark-brown to black soils and brown subsoils showing white mottlings in the lower section, caused by the presence of calcareous material. The topography is nearly level, and surface drainage is poor, while percolation and subdrainage is arrested by the relatively impervious subsoils. The members of the series are derived from unconsolidated Tertiary deposits, mainly from crystalline rocks of the Rocky Mountains, and distributed as broad alluvial foot slopes and outwash plain deposits by aggrading streams. The material has in this series been locally modified by later alluvial material. The series occupies depressed basins or valleys formed by the solution of deeper-seated salt or gypsum beds. The soils are supplied with moisture from subsurface waters, and are generally productive. Alfalfa is the principal crop. Corn, wheat, and forage crops are grown to some extent.

Area and distribution of the soil of the Fowler series.

Soil name.	State or area.[1]	Acres.
Fowler silty clay loam	Kansas 10	41,472

[1] For key to number in this column see p. 733.

Gannett series.—The soils are light brown, with yellowish sand to light sandy loam subsoils extending to a depth of 30 inches. The series consists of local alluvial outwash material derived from wind-laid sands and sand hills and deposited by surface waters. It is associated in occurrence with the sand hills in valley bottoms along the sandy bluffs. The topography is generally level, with a gradual slope toward the valleys. Drainage is usually well established. The series is seldom cultivated, most of it being utilized as pasture, but under favorable moisture conditions it is adapted to vegetables.

Area and distribution of the soil of the Gannett series.

Soil name.	State or area.[1]	Acres.
Gannett fine sand	Nebraska 7; South Dakota 3	783,360

[1] For key to numbers in this column see p. 733.

Greensburg series.—The soils are brown to dark brown in color and the subsoils brown to yellowish brown. The soils are derived mainly from the Plains Marl or calcareous unconsolidated material of the Tertiary deposits, formed predominantly from crystalline rocks and modified by some material from sedimentary rocks, distributed by shifting aggrading streams and winds. The soils occupy level to rolling upland plains, are usually treeless, and are related to the soils of the Richfield and the Pratt series. They differ from the Pratt soils in the absence of the red color and from the Richfield series in a lower lime content and the absence of calcareous mottlings in the subsoils. They are well drained and retentive of moisture. Under favorable climatic conditions the members are productive and adapted to staple farm crops of the region in which they occur. Wheat, corn, and forage crops, consisting mainly of kafir and sorghum, are the principal products.

Area and distribution of the soils of the Greensburg series.

Soil name.	State or area.[1]	Acres.
Greensburg sandy loam	Kansas 10	76,032
undifferentiated	do	698,112
Total		774,144

[1] For key to number in this column see p. 733.

Lebanon series.—The Lebanon soils are gray to brownish gray, and usually contain a high percentage of silt. In local areas of poor surface drainage the soils are nearly black and the subsoils mottled with brown, yellow, red, and gray. Typically the upper subsoil is a yellowish silty clay loam, grading into a deeper subsoil of plastic, tough, impervious clay of yellowish-brown to chocolate-brown color, which in turn grades into a more friable layer of somewhat lighter textured material of mottled yellow, gray, and drab color. A so-called hardpan of reddish and gray chert fragments, often firmly cemented, is usually encountered within the 3-foot section. Where erosion has been active, fragments from an underlying chert formation have been distributed over the surface and throughout the soil. The topography is typically flat to undulating, the series being developed over the smooth, higher parts of divides in the Ozark region. The soil is derived from a surficial chert-free layer of clays covering this high, smooth country, and consisting probably of stream outwash material apparently derived from crystalline, sandstone, shale, and limestone rocks. The chert fragments and the "hardpan" consist of a cherty limestone formation underlying the surficial strata. These soils were originally prairie, with only an occasional clump of blackjack oaks. Blackjack is now abundant over unused areas. In agricultural value these solis do not rank high, but they can be improved by good management. They are best adapted to grain, grass, and clover.

Area and distribution of the soils of the Lebanon series.

Soil name.	State or area.[1]	Acres.
Lebanon stony loam	Missouri 11	6,272
silt loam	Missouri 8, 11	102,080
Total		108,352

[1] For key to numbers in this column see p. 733.

Orella series.—The soils are grayish brown to yellowish brown and of variable depth. The subsoils are greenish gray to red or yellow. The series is marked by the highly colored subsoils. The soil material in the heavier members is compact and is tilled with some difficulty. The soils are derived from unconsolidated sandy clay of the Tertiary formations, mainly from shale and sandstone, but with some material from granite rocks, and distributed by aggrading streams as alluvial outwash plain, foot slope, or fan deposits. They occur upon comparatively level or undulating plains, which in the vicinity of streams frequently become eroded or dissected. Where the climate is favorable the soils are adapted to small grains, corn, and forage crops. Small grain, corn, and potatoes constitute the leading products.

Area and distribution of the soil of the Orella series.

Soil name.	State or area.[1]	Acres.
Orella undifferentiated	Nebraska 7	18,432

[1] For key to number in this column see p. 733.

Orman series.—The soils are grayish brown to dark brown, and generally of compact structure, with grayish-brown to drab subsoils similar in texture and structure to the soils. The members of the series occupy poorly drained, flat valley bottoms and gentle hill slopes. They consist of alluvial stream outwash or alluvial surface wash deposits derived from shales, some of the material having been deposited in shallow waters of temporary lakes. Alkali salts are frequently present in injurious quantities. The soils are utilized mainly for grazing, but if properly drained and irrigated they are well adapted to alfalfa and cereals.

Area and distribution of the soil of the Orman series.

Soil name.	State or area.[1]	Acres.
Orman clay	South Dakota 3	327,168

[1] For key to number in this column see p. 733.

Pratt series.—The soils are brown, with dark reddish brown, rather compact and sticky subsoils, which usually range in texture from loam to clay loam and contain small amounts of gravel. They are derived from the weathering of the more or less sandy and gravelly unconsolidated Tertiary material of the western prairies and plains, derived predominantly from crystalline rocks and distributed as broad alluvial mountain foot slope or outwash plain deposits by aggrading streams. The mineral particles consist largely of fragments of feldspar. The topography is rolling to undulating, with occasional hummocks due to wind action. Drainage is well established. Under favorable textural and climatic conditions the soils are quite productive, and good yields of corn, kafir, sorghum, and wheat are obtained. The sandy members hold large supplies of water, and crop yields are more certain than upon most sandy soils in other sections of the country.

Area and distribution of the soils of the Pratt series.

Soil name.	State or area.[1]	Acres.
Pratt loamy sand	Kansas 10	400,896
loamy fine sand	Kansas 6	55,360
sandy loam	Kansas 10, 11	493,888
fine sandy loam	Kansas 6	123,072
very fine sandy loam	do	20,864
loam	Kansas 6, 10, 11	264,960
sandy clay loam	Kansas 6	1,408
silty clay loam	do	23,424
undifferentiated	Kansas 10	449,280
Total		1,833,152

[1] For key to numbers in this column see p. 733.

Richfield series.—The soils are grayish brown with grayish-brown calcareous subsoils. The members are derived from unconsolidated or partially consolidated calcareous Tertiary deposits, derived predominantly from the feldspar-bearing, crystalline rocks of the Rocky Mountains, and distributed by earlier aggrading streams as low, broad alluvial foot-slope or stream outwash plain deposits. The soils are related to those of the Pratt series, from which they are distinguished by the absence of the reddish color. They occupy comparatively level to sharply rolling areas, are generally well drained, and are retentive of moisture. With good climate they are adapted to staple farm crops, and certain of the members to melons and truck crops. Wheat, corn, alfalfa, and forage crops are the principal products.

Area and distribution of the soils of the Richfield series.

Soil name.	State or area.[1]	Acres.
Richfield sand	Kansas 3	10,944
fine sandy loam	Nebraska 7	743,744
loam	Kansas 10	239,616
silt loam	do	3,369,088
silty clay loam	Kansas 10; Texas 22	1,161,216
undifferentiated	Kansas 10; Nebraska 7	2,518,848
Total		8,043,456

[1] For key to numbers in this column see p. 733.

Rosebud series.—The surface soils are dark-gray or brown. The subsoils are light colored, almost white, and very calcareous. A characteristic feature of this series is the white or pale color of the deeper subsoil. These soils are derived from light-colored, very calcareous, unconsolidated Tertiary deposits derived mainly from sandstone, limestone, and shale rocks, but including some material from crystalline rocks and distributed as alluvial fan or mountain foot slopes by aggrading streams. The topography ranges from undulating to steeply rolling. In places the surface is excessively eroded or dissected, forming areas of "bad land." The soils easily erode, the more hilly areas especially being dotted with bare white spots.

Area and distribution of the soils of the Rosebud series.

Soil name.	State or area.[1]	Acres.
Rosebud loamy fine sand	Nebraska 7	101,376
fine sandy loam	Nebraska 7; South Dakota 3	1,389,312
silt loam	do	3,919,104
undifferentiated	South Dakota 3	205,056
Total		5,614,848

[1] For key to numbers in this column see p. 733.

Sedgwick series.—The soils are black and have bluish-gray, compact, heavy subsoils. The series occupies depressed areas of deficient drainage in upland prairies or at the base of hill slopes. The soils consist of alluvial material from the erosion of slopes of shale and sandstone soils, deposited as alluvial slope or fan material by sheet surface waters or by small intermittent streams. The deeper su`soils are sometimes residual from underlying shale, sandstone, and limestone. `The soils cover extensive areas and are generally used for grazing, but under favorable conditions of drainage and climate are well adapted to corn, wheat, and other cereals.

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Area and distribution of the soil of the Sedgwick series.

Soil name.	State or area.[1]	Acres.
Sedgwick clay loam	Kansas 11; Missouri 3	8,064

[1] For key to numbers in this column see p. 733.

Tishomingo series.—The soils are brown and usually contain a variable quantity of small fragments of granitic rock. The subsoils also contain granitic fragments, are of heavy texture, and red to drab in color. At a depth of about 3 feet a substratum of partially disintegrated bedrock is sometimes encountered. The soil material consists mainly of granitic material distributed by surface wash or minor streams as outwash plain material or alluvial fan deposits. The subsoil is in part residual from granitic rocks. The topography varies from comparatively level to rolling. The members of the series are not extensively utilized except for grazing or for the production of wild hay, and are not of great agricultural importance. The more rolling areas usually support a growth of scrub oak. Cotton and corn give fair yields.

Area and distribution of the soil of the Tishomingo series.

Soil name.	State or area.[1]	Acres.
Tishomingo gravelly sandy loam	Oklahoma 2	29,696

[1] For key to number in this column see p. 733.

Zapata series.—The Zapata series consists of gray calcareous soils with subsoils of similar color and texture underlain by a stratum of limestone or occasionally sandstone at depths ranging from a few inches to 3 or 4 feet. The topography is rolling to hilly. This feature, together with the nearness of the underlying bedrock, distinguishes this series from the associated Brennan soils. The soils have been derived from a thin surface mantle of gray to slightly yellowish, sandy alluvial outwash, representing the weathered product of shale and sandstone rocks, and distributed by surface sheet waters or by shifting aggrading and intermittent streams over the limestone and sandstone rocks. Drainage is well established. Owing to the hilly topography, nearness of the underlying rock, and light rainfall, the soils of this series have a very low value for agriculture. They are generally utilized for grazing, to which purpose they are best adapted.

Area and distribution of the soils of the Zapata series.

Soil name.	State or area.[1]	Acres.
Zapata fine sandy loam	Texas 27	638,208
loam	do	34,560
undifferentiated	Texas 28	292,608
Total		965,376

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The soils of the sand group, representing the alluvial fan or unconsolidated stream and outwash plain material of Tertiary age in the Great Plains region, have been encountered under two soil series. They are of widespread and extensive occurrence in the middle eastern part of the region.

The surface is usually undulating, but typically windblown, and often marked by dunelike hillocks and intervening depressions. The soil is deficient in

organic matter and loose and porous, although sometimes coherent when moist. Drainage is excessive, and the soils drift when dry if disturbed or where unprotected by native vegetation.

The soils occur in regions of pronounced semiarid climate and are not usually capable of being irrigated. They are generally used only for grazing. Small local areas are sometimes devoted to the culture of sorghum and other forage crops where moisture conditions are exceptionally good.

Except where capable of irrigation the soils are not adapted to agriculture. With the application of irrigation water and where protected from injurious winds, they are well adapted to early stone fruits, small fruits, melons, and truck crops.

Colorado sand.—The soil consists of a light-gray to yellowish or reddish brown, medium to rather fine sand usually 6 feet or more in depth. The structure varies from loose and porous over unprotected areas, subject to wind drifting, to sticky and compact in areas where the weathering of the underlying material is more advanced. Gravel is ordinarily present. Rock outcrops are of frequent occurrence. Micaceous and feldspathic material is also encountered in large quantities. The type occurs on sloping or rolling plains and dome-like elevations and ridges. It consists mainly of ancient stream-borne material deposited over extensive foot slopes and derived from the harder rocks of the Rocky Mountains, modified in places by residual material from the underlying sandstone. Drainage is well established and the soil free from alkali. The type is adapted to fruit and truck crops where not too loose and leachy. It generally lies too high for irrigation.

Richfield sand.—The soil is light-brown to grayish-brown porous sand. The subsoil is of practically the same material, with no change in color. The topography is gently rolling, and leveling is necessary in preparing the soil for irrigation. The type is derived from more or less unconsolidated Tertiary deposits distributed by earlier streams as extensive alluvial fan or foot-slope material and derived predominantly from crystalline rocks. These deposits have been subsequently modified by wind-blown material derived from alluvial soils occupying stream valleys. The surface is loose in texture and drifts readily when disturbed by cultivation. The type is utilized mainly for grazing. Small amounts of sorghum or other forage crops are grown locally.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Colorado sand	Colorado 2, 3	128,576
Richfield sand	Kansas 3	10,944
Total		139,520

[1] For key to numbers in this column see p. 733.

LOAMY COARSE SAND PHASE.

This phase includes sandy soils of coarse texture and of distinctly loamy character, becoming noticeably coherent when wet and resembling the sandy loams in field characteristics. Such soils are of somewhat unusual occurrence and in this province have been encountered under only one soil series.

The texture of the soil material is such as to render it less susceptible to wind drifting than are the soils of the sand group. The subsoil, however, is of gravelly texture and open, porous structure, which, with the prevailing undulating to rolling topography, renders drainage thorough and often excessive and the soil deficient in moisture-retaining capacity. Crops often suffer during periods of drought.

Under similar climatic conditions this series would probably not depart essentially in agricultural importance from the members of the sand group of this province. The rainfall, however, is somewhat heavier than that of the sands. Corn, small grains, alfalfa, and forage crops are grown with fair success. The average yields are low, and the type is not well adapted to general farming. Where capable of irrigation the soils should prove well suited to the production of early stone fruits, small fruits, and truck crops.

Albion loamy coarse sand.—This consists of a dark-brown, loamy coarse sand about 12 inches deep, underlain to 36 inches or more by a brown to reddish-brown subsoil containing somewhat more fine gravel and coarse sand than the soil. The topography is gently undulating to slightly rolling. Surface drainage is always good, although the presence of gravel in the subsoil often makes underdrainage excessive and the soil droughty. The type is derived from the somewhat gravelly phases of the unconsolidated Tertiary material formed predominantly from crystalline rocks and distributed as broad alluvial outwash plains material by aggrading streams. Corn, kafir, sorghum, and some wheat and alfalfa are grown, though yields are rather low, especially in dry seasons.

Area and distribution of the loamy coarse sand.

Soil name.	State or area.[1]	Acres.
Albion loamy coarse sand	Kansas 6	11,968

[1] For key to number in this column see p. 733.

LOAMY SAND PHASE.

The loamy sand in this province, like the coarse loamy sand, has been recognized under but one soil series.

The soil and subsoil material is of somewhat finer texture than that of the coarse loamy sand. When dry, the surface material is incoherent and subject to wind blowing in exposed localities. When moist, it is slightly sticky. The subsoil is more loamy in texture and of compact structure, and possesses well-developed moisture-retaining properties. Drainage is usually thorough, but the soil is of mellow and friable structure, and is easily maintained in a condition of tilth favorable to the conservation of moisture.

Only a light farming equipment is required, but careful management is necessary to prevent wind drifting and undue loss of moisture from evaporation. The normal rainfall is light, and in dry seasons is not sufficient to render crop yields certain.

In general agricultural value and adaptation to crops this type is more closely related to the sandy loams than to the soils of the sand groups. It is best adapted to a rather light type of farming, and where the water supply is adequate it is well suited to early fruits, melons, cantaloupes, tomatoes, or other earlier or lighter truck crops. It is devoted mainly to the production of corn, sorghum, and wheat.

Pratt loamy sand.—The type consists of a reddish or yellowish brown, rather loose, loamy sand about 18 inches deep, grading into a reddish loamy sand, whose slightly heavier texture is due to a small content of sticky clay. The surface soil is incoherent when dry, and if worked while too loose is likely to drift. The topography varies from level to rolling, and sand dunes are numerous. The material composing this type has been derived from the sandy strata of the unconsolidated Tertiary material, reworked by the wind and more or less weathered in its present position. The parent material is derived predominantly from crystalline rocks and has been distributed as broad, alluvial mountain foot-slope or outwash plains by aggrading streams. The minerals present include an abundance of feldspathic fragments. The type is well drained, but retentive of moisture. Corn, sorghum, and wheat are the principal crops. With sufficient rainfall the soil is very productive.

Area and distribution of the loamy sand.

Soil name.	State or area.[1]	Acres.
Pratt loamy sand	Kansas 10	400,896

[1] For key to number in this column see p. 733.

Fine Sand Group.

The fine-sand group of this province. in so far as mapped, embraces only a single member. The soil is loose and incoherent, and is underlain by a porous subsoil. The rainfall is usually too light for extensive cultivation without irrigation, and the type is generally so situated that irrigation is not practicable. Drainage is well established, and the type is not retentive of moisture. Where capable of irrigation or favored by sufficient rainfall, the type is well adapted to tomatoes, melons, and other early crops. It is utilized mainly for pasture, and in agricultural importance ranks with the soils of the sand group of the province. It is not well adapted to general farming, but if frequently and thoroughly irrigated fair yields of alfalfa could probably be grown.

Gannett fine sand.—The soil is a light-brown, fine or loamy fine sand to a depth of 8 to 12 inches. The subsoil is a yellowish fine sand to light fine sandy loam or sandy loam 30 inches deep. The type occurs in valley bottoms along bluffs in the sandhill regions, and owes its formation to local alluvial wash from this material transported by rains and minor intermittent streams. The topography is generally level, with a gradual slope toward the valleys, and the type is well drained. It is seldom cultivated, most of it being used for pasture. Under favorable moisture conditions it is well adapted to truck crops.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Gannett fine sand.............	Nebraska 7; South Dakota 3....................................	783,360

[1] For key to numbers in this column see p. 733.

LOAMY FINE SAND PHASE.

The loamy fine sand of the alluvial outwash or foot-slope plain province in the Great Plains region has been recognized only under one soil series.

The soil and subsoil material is usually friable and porous, although noticeably sticky when wet and having to a moderate degree the physical properties of a fine sandy loam. When dry the surface material is quite incoherent and in exposed localities is sometimes wind blown. The soil is readily permeated by surface waters, little moisture being lost by run-off. The maintenance of a dust mulch is the best means of checking evaporation and surface loss of moisture. The type is superior in agricultural value to the normal fine sand of the province. The rainfall is generally limited, and irrigation is possible only on a few favorably situated areas. Fair crops are produced under intensive cultivation. The type is devoted mainly to the production of corn, wheat, sorghum, kafir, and similar drought-resistant forage crops. Where capable of irrigation the soil should be well suited to the production of early small fruits, tree fruits, and vegetables. In its utilization and agricultural possibilities it is associated with the soils of the sandy loam and fine sandy loam groups. It requires but a light farming equipment.

Pratt loamy fine sand.—The type includes a dark-brown to grayish-brown loamy fine sand underlain at a depth of 12 to 18 inches by a reddish-brown, rather fine sand. The topography is rolling to undulating, with occasional dunes caused by drifting sand. The type is derived from the unconsolidated Tertiary material originating from crystalline rocks, containing a large amount of feldspar fragments, and distributed as low, broad extensive foot-slope or outwash plain deposits by aggrading streams, subsequently more or less modified by wind action. Drainage is well established, but owing to the porous structure of the type there is very little run-off of surface waters. With intelligent methods of cultivation, fair supplies of moisture are conserved for crop use and fair yields of corn, sorghum, kafir, and wheat are produced.

Rosebud loamy fine sand.—The soil consists of a light-gray, pervious loamy fine sand. The subsoil resembles the soil, but has a slightly lighter color and is more incoherent. The topography ranges from undulating to hilly and broken, the greater part of the type being too rough for cultivation. The soil is derived from the indurated or sandstonelike material of the Arickaree formation of the Tertiary deposits in the Great Plains. It is porous and leachy, of

rather low moisture-retaining capacity, and is generally utilized for grazing. It supports a good growth of native grasses, and is on the whole best suited to this purpose.

Area and distribution of the loamy fine sands.

Soil name.	State or area.[1]	Acres.
Rosebud loamy fine sand	Nebraska 7	101,376
Pratt loamy fine sand	Kansas 6	55,360
Total		156,736

[1] For key to numbers in this column see p. 733.

Sandy Loam Group.

The sandy loams in this province are of frequent occurrence, particularly in the central and west-central sections of the Great Plains region. They have been recognized under four important series of soils and cover extensive areas.

The soil is friable and easily maintained in a mellow structural condition. The subsoils are heavier than the surface soil, and their rather compact structure retards excessive underdrainage. They are of high moisture-holding capacity. The principal soil areas are subject to a light rainfall and in the western districts the practice of agriculture without irrigation is hazardous. The topography is usually sloping or nearly level to rolling, but the surface is sometimes broken by wind-blown undulations, stream valleys, or outcropping ledges of rock. Drainage is well established, except in local depressions subject to accumulations of surface flood waters or of seepage waters from irrigation.

The soils of this group are retentive of moisture under cultivation and require only a light farming equipment. In districts where the rainfall is sufficient to maintain agriculture without irrigation they constitute good soils for general purposes, well adapted to a rather light type of general farming and to vegetables and other special crops. They are in favorable seasons superior to the soils of heavier texture for the production of general farm crops, because their physical structure is more favorable to the conservation of moisture. Corn, wheat, kafir, sorghum, and milo are the crops most extensively grown. Alfalfa is an important product in the irrigated districts and is grown locally, where the natural moisture supply is sufficient, without irrigation. Tree fruits and vegetables are grown to a limited extent, and melons, cantaloupes, and sugar beets constitute important products in the western irrigated areas. Owing to the dominant heavy, moisture-retaining subsoils, the sandy loams of the province are better adapted to general farming than are most of the sandy loam groups of this or other regions.

Albion sandy loam.—The soil is a dark-brown, rather coarse sandy loam from 8 to 14 inches deep, and is underlain by a red to reddish-brown sandy clay carrying larger quantities of coarse sand and fine gravel. While there is comparatively little silt or very fine sand in the subsoil, the amount of clay is sufficient to make it sticky and retentive of moisture. The type is formed from the sandy and fine gravelly phases of the unconsolidated Tertiary material, derived predominantly from crystalline rocks of the Rocky Mountains. It occurs as broad, extensive alluvial mountain foot-slope or outwash plain deposits built by aggrading streams. The topography is gently undulating to rolling. Corn, kafir, wheat, sorghum, and alfalfa give fair yields, and the type as a whole has a high agricultural value. Some tree and small fruits are also grown. The type is well adapted to vegetables.

Colorado sandy loam.—The soil is a reddish or yellowish-brown sandy loam of medium to fine texture and rather compact structure, but friable under cultivation. It varies from 1 to 3 feet in depth and is underlain by a compact, sticky, reddish-brown or yellowish-brown loam or sandy loam of adobe structure. The type varies in texture and structure, however, being modified in some areas by wash from other soils. It is typically developed on the semiarid slopes of the Great Plains. It is frequently marked by gravel-strewn bluff or terrace lines and outcropping ledges of shales, sandstones, or limestones. The soil often carries a small quantity of fine gravel. The type is derived from ancient foot-slope material from granitic rocks, modified by later stream erosion,

alluvial deposition, and by residual and wind-blown material. It is usually well drained, free from alkali, easily cultivated, and retentive of moisture. Alfalfa, melons, sugar beets, fruits, and vegetables give good results on favorably situated areas capable of irrigation.

Greensburg sandy loam.—The soil consists of a brown to reddish-brown sandy loam, with an average depth of 18 inches. The subsoil is a heavy brown silt loam, becoming heavier with depth. The typical heavy subsoil and the absence of the red color distinguishes it from the soils of the Pratt series. The topography is rolling. The type probably represents a mixture of material resulting from unconsolidated silty Tertiary deposits of the Plains Marl and wind-blown material subsequently well weathered in its present position. It is a good general-purpose soil and a variety of crops are grown. Wheat, corn, and kafir are the principal crops.

Pratt sandy loam.—The type is a reddish-brown or brown medium to fine sandy loam from 20 to 24 inches deep, underlain by a lighter reddish-brown subsoil, which is slightly more sandy but somewhat sticky and compact, owing to its clay content. The type is derived from the weathering of sandy unconsolidated Tertiary material, mainly from crystalline rocks, and consisting to a large extent of feldspar particles, distributed as alluvial mountain foot-slope and outwash plain deposits by aggrading streams. The topography varies from nearly level to dunelike hills, and the surface material is sometimes wind blown. Drainage is well established, and the type is retentive of moisture. Wheat, corn, and kafir are the principal crops, yields being good in favorable seasons.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Pratt sandy loam	Kansas 10, 11	493,888
Colorado sandy loam	Colorado 3	156,096
Albion sandy loam	Kansas 6	89,984
Greensburg sandy loam	Kansas 10	76,032
Total		816,000

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam in this province has been recognized under but one soil series, which is represented by the gravelly sandy loam member.

The gravel content usually becomes more marked in the subsoil, the soil mass often being underlain at shallow depths by granite bedrock. The topography varies from comparatively level to broken. Cotton and corn are the principal products, but the type is not extensively developed to agriculture. It is deficient in moisture-retaining capacity and crops suffer from drought. The soil is of little value for general farming, and in agricultural importance is much inferior to the sandy loam soils of this province.

Tishomingo gravelly sandy loam.—The soil is a brown sandy loam containing a variable quantity of small gravel and has an average depth of 10 inches. The subsoil is a red to drab gravelly clay, the gravel content being usually greater than that of the soil. In some places the gravel increases rapidly, and at a depth of 3 feet a substratum consisting of a mass of disintegrated rock fragments is encountered. The type occupies nearly level to rough, rolling areas. The surface material consists mainly of stream outwash or alluvial slope material. The subsoil is in part residual and derived from the Tishomingo granite. The more level areas of the type form prairies covered with wild grasses, which furnish good grazing and a fair grade of hay. A growth of scrub oak is generally found over rolling areas. Cotton and corn give fair yields, but the type is not extensively utilized. Its value for general farm crops is low.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Tishomingo gravelly sandy loam	Oklahoma 2	29,606

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loam soils of the province are widely distributed throughout the northern, central, and southern sections of the Great Plains region, where they are recognized under three soil series. They are less extensive and important, however, than the soils of the sandy loam group, and are subject to much wider range in topography, character of underlying material, and in crop adaptation. The subsoils are prevailingly heavier than the surface soils. The topography is predominantly undulating or rolling, and in some of the members the surface is frequently eroded or dissected. In the rougher districts the soils are shallow and sometimes stony.

The member occurring under the Pratt series is retentive of moisture under cultivation, friable, and moderately tenacious when wet, and constitutes a fair soil for the general farm crops and vegetables. Kafir, broom corn, wheat, and alfalfa are the principal crops grown.

The other members of the group are less extensively utilized and moisture conditions are less favorable for agriculture. Where of sufficient depth and favorable topography, the more northern areas are better adapted to corn, potatoes, and other intertilled crops than to small grains. In the southwestern semiarid areas, occupied by the fine sandy loam of the Zapata series, the soil is generally shallow and hilly. It is insufficiently supplied with moisture to insure crop returns and is better adapted to grazing.

Pratt fine sandy loam.—The soil consists of a dark grayish brown to dark-brown fine sandy loam from 10 to 18 inches deep, and is underlain by a somewhat lighter brown or reddish-brown, heavier, and more compact subsoil. The surface clods to some extent, though as a rule good tilth is easily maintained. The topography is gently rolling to undulating, though in some areas its dunes are formed by wind action. Drainage is well established. The type is derived from the unconsolidated sandy material of the Tertiary formations derived from crystalline rocks and distributed by aggrading streams as low, broad mountain foot slopes or alluvial outwash-plain deposits. It contains a large amount of feldspathic mineral fragments and holds moisture fairly well. Kafir, broom corn, wheat, and alfalfa give fair yields under favorable conditions. The soil is also adapted to vegetables and truck crops and to fruit.

Richfield fine sandy loam.—The soil to about 12 inches in depth is light brown or gray and has a fine, silty texture and loose, porous structure. The subsoil is generally similar to the soil material in color and character. The topography is gently rolling or undulating, the steeper slopes being sometimes eroded and rough or broken. In certain localities the surface is marked by wind-blown mounds or knolls. The type is derived from Tertiary deposits in varying degrees of consolidation, subsequently modified by eolian agencies. Drainage is usually well established. The rougher areas are utilized mainly for grazing. The type is generally retentive of moisture under cultivation, and with favorable topography and sufficient rainfall is adapted to general farming. Corn and sorghum are the principal crops. Small grains are grown to some extent, but yields are low on account of the light rainfall.

Rosebud fine sandy loam.—The soil consists of a dark-gray or brown fine sandy loam from 12 to 18 inches deep, containing a high percentage of silt. The subsoil is lighter in color, often being almost white in the lower depths, and is calcareous. The type is derived from the weathering of unconsolidated Tertiary deposits, modified to some extent by wind-blown sand. The parent material of the Tertiary deposits consists of extensive alluvial fan or mountain foot-slope materials, derived largely from sandstone, shale, and limestone rocks, but including some granitic material transported and distributed by aggrading streams. The surface is gently undulating to steeply rolling, with broken areas and formations resembling buttes. Very little of the type is at present under cultivation. Where not too sandy it is adapted to general farming. Corn,

potatoes, and vegetables could probably be more successfully grown than small grains.

Zapata fine sandy loam.—To a depth of 6 to 12 inches the soil consists of a gray to grayish-brown fine sandy loam underlain by a hard, compact, heavy fine sandy loam or sandy clay similar to or lighter in color than the surface material. At depths ranging from a few inches to 3 or 4 feet a substratum of bedrock consisting of limestone and occasionally sandstone is encountered. Outcrops frequently occur and give the soil the character of a stony loam. The type has been formed from a thin mantle of gray sandy loam or sandy clay consisting of alluvial outwash deposits derived mainly from sandstone and shale rocks and deposited over the bedrock. The topography varies from rolling to hilly and in some places is quite broken. This is distinctly a grazing type and should be devoted to this purpose. Much of it is so hilly and stony or has the limestone so near the surface that it can never be used for farming.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Rosebud fine sandy loam	Nebraska 7; South Dakota 3	1,389,312
Richfield fine sandy loam	Nebraska 7	743,744
Zapata fine sandy loam	Texas 27	638,208
Pratt fine sandy loam	Kansas 6	123,072
Total		2,894,336

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

The very fine phase of the fine sandy loam group is confined to a single soil series occurring in the middle of the Great Plains region.

The surface material is finer, more compact, and somewhat more sticky when wet than is the soil of the fine sandy loam of the same series. It requires more careful management than the lighter-textured soils of the province. If cultivated when too wet, it clods to some extent. With favorable moisture conditions the soil is friable and readily maintained in good tilth. Only a moderately heavy farming equipment is necessary. The type retains moisture, and where the climate is favorable it constitutes a good general-purpose soil. Kafir, sorghum, wheat, and alfalfa are the principal products. The soil is somewhat better adapted to general or heavy farming than the fine sandy loam member of the same series, and in general adaptation to crops it occupies a position intermediate between the soils occurring under the same series in the fine sandy loam and the loam groups.

Pratt very fine sandy loam.—The soil consists of a brown or light-brown rather sticky very fine sandy loam from 12 to 15 inches deep. The subsoil is a reddish or yellowish-brown compact and sticky heavy loam or silty clay loam. The surface soil clods to some extent, especially if cultivated under unfavorable conditions of moisture. The topography is nearly level to gently undulating. Occasional small depressed areas show traces of alkali. Drainage is, however, usually well established and the soil fairly retentive of moisture. The soil owes its origin to the unconsolidated material of the Feldspar formations, derived mainly from crystalline feldspar-bearing rocks, and deposited by aggrading streams as alluvial outwash plains or mountain foot-slope deposits. It has been modified to a slight extent by material of the same character which has been transported by winds. It is a good agricultural soil and produces fair to good yields of kafir, sorghum, wheat, and alfalfa.

Area and distribution of the very fine sandy loam.

Soil name.	State or area.[1]	Acres.
Pratt very fine sandy loam	Kansas 6	20,864

[1] For key to number in this column see p. 733.

Loam Group.

The loam soils of this province are of extensive occurrence throughout the middle and southern portions of the Great Plains region.

The soils vary widely in rainfall, topography, depth, character of underlying material, and agricultural importance. Although the members of the group are usually subject to a light rainfall, they are generally retentive of moisture under cultivation where carefully and judiciously managed. The subsoil is usually moderately heavy to heavy and of high water-holding capacity, though one of the members is marked by a porous subsoil and by somewhat excessive underdrainage; but this type is favored by a more generous rainfall than the areas covered by the other soils of the loam group. The topography is generally undulating to gently rolling, but is sometimes eroded or rough and broken. Drainage as a rule is well established.

A large part of the areas covered by the soils of the loam group is as yet undeveloped to agriculture and is used extensively for grazing purposes. When devoted to agriculture, corn, wheat, alfalfa, and kafir, sorghum, milo, broom corn, and similar drought-resistant forage crops are the principal products, the latter being most extensively grown in the western and southwestern portions of the districts covered. Some cotton is grown in the southern districts.

The soils are usually sticky when wet and require somewhat more careful management to prevent puddling and an unfavorable structure than is the case with the groups of lighter texture. Under favorable moisture conditions they are easily worked.

The loam of the Zapata series, occurring in the southwestern part of the Great Plains region under pronounced conditions of aridity, is predominantly shallow and often of rough topography. It is best adapted to grazing purposes. The other members of the group can generally be used for crops and constitute important general-farming soils. They are adapted to a rather heavy type of agriculture and require a heavy and complete farm equipment for efficient and economical utilization.

Albion loam.—The surface soil consists of a dark-brown rather heavy loam from 10 to 14 inches deep, becoming nearly black when wet. It is underlain by a reddish-brown to brownish-red clay, which contains a considerable amount of coarse sand and fine gravel. Fine chert particles occur in the subsoil. The soil contains enough clay to make it somewhat sticky when wet, and unless worked under favorable moisture conditions, is inclined to clod. The topography is undulating to rolling. Surface drainage is usually good. Underdrainage is excessive on account of the gravel in the subsoil. The type, however, is not so droughty as some of the coarse textured members of the series, and where intelligently farmed gives good yields of corn, wheat, kafir, sorghum, and alfalfa. The type is derived from unconsolidated sandy and gravelly material of the Tertiary formation composed mainly of crystalline rocks, distributed by aggrading streams as extensive broad alluvial foot slopes or stream-outwash plain deposits.

Amarillo loam.—The surface soil consists of a dark-brown or occasionally a reddish-brown heavy sandy loam to loam ranging in depth from 8 to 14 inches. The subsoil is a brown or reddish-brown heavy sandy loam or heavy loam. A white calcareous clay is encountered under the subsoil at depths ranging from 8 to 30 inches. The topography varies from gently undulating to rolling or sometimes broken. Drainage is ordinarily well established. This soil has been formed from the weathering of unconsolidated Tertiary and Quaternary deposits derived from sedimentary and crystalline rocks and distributed by aggrading streams as alluvial fan, outwash plain, or mountain foot-slope material. The type is well suited to dry farming methods, is a productive soil well adapted to a large number of crops, is easily cultivated, and does not suffer from extensive wind drifting. It is utilized mainly for grazing and for the production of wheat, forage crops, and, to a limited extent, for corn, cotton, alfalfa, potatoes, and vegetables.

Pratt loam.—The soil is a brown, friable silt loam to an average depth of 18 inches. The subsoil to 36 inches is a reddish-brown sticky, rather compact sandy loam, the red color becoming more pronounced with depth. The topography is generally rolling, and drainage is well established. The type is derived from the weathering of a sandy stratum in the unconsolidated Tertiary material originating mainly from crystalline rocks, containing a large amount of feldspar fragments, and deposited by aggrading streams as broad alluvial foot-slope and outwash plain deposits. It is a good wheat soil and is adapted to kafir and corn.

Richfield loam.—The soil is a grayish-brown to brown loam. The subsoil is grayish brown or yellowish brown in color, and extends to a depth of more than 36 inches. The topography is comparatively level to undulating or rolling. The soil is derived from unconsolidated or partially cemented, calcareous Tertiary deposits laid down by aggrading streams as extensive mountain foot slopes or alluvial fans and derived mainly from material from crystalline rocks. Some of the areas have subsequently been modified by weathering in place or by eolian or alluvial agencies. Wheat, corn, and alfalfa are grown to some extent, but the sorghums are more profitable.

Zapata loam.—The type consists of a light-gray to grayish-brown loam from 6 to 10 inches deep, underlain by slightly heavier gray to yellowish-gray or slightly pinkish loam. Sandstone or limestone bedrock substratum is usually encountered at a depth of 3 feet and outcrops sometimes occur on the steeper slopes. The type is very low in humus, but contains a large percentage of lime. The soil is formed from thin deposits of alluvial stream or sheet water outwash material, derived mainly from sandstone and shale rocks and deposited over the bedrock, which has apparently had some influence upon the character of the soil. The surface is usually rolling to hilly. None of the type is cultivated, and owing to its position is best left for pasture.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Amarillo loam	Texas 22	1,294,848
Pratt loam	Kansas 6, 10, 11	264,960
Richfield loam	Kansas 10	239,616
Albion loam	Kansas 6	48,384
Zapata loam	Texas 27	34,560
Total		1,882,368

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony loam has been recognized in this province under but one soil series, and is not extensively developed or of great agricultural importance.

The stone content is usually sufficient to interfere with cultivation, and the topography over a large part of the area is such as to prohibit the extensive use of farm machinery. The soil is more open and porous than that of the loams in the province. A hardpan, consisting of chert fragments and finer interstitial soil material cemented by lime or by iron salts, commonly occurs in the subsoil material. The soil is not extensively utilized and its agricultural possibilities are restricted. When improved by the removal of stones, some of the less hilly and broken areas could be used for shallow-rooted grains and grass crops.

The soil of this phase departs widely from the soils of the loam group in this province, and is far less valuable for agriculture.

Lebanon stony loam.—The soil to a depth of 6 or 7 inches is a gray to brownish-gray friable silt loam containing little organic matter and carrying from 20 to 30 per cent of chert fragments, varying in size up to 12 inches in diameter. The subsoil consists of a brown or yellowish-brown silty clay loam or silty clay underlain by a tough, plastic yellowish-brown clay. The subsoil carries about the same amount of chert fragments as the soil. Chert gravel and larger fragments are encountered at depths varying from 12 to 16 inches. Underlying the tough clay, which usually extends from 18 to 22 inches, there is generally a thin stratum, 4 or 5 inches thick, of friable silty clay or silty clay loam mottled with yellow, drab, and gray. A "hardpan," consisting of angular chert fragments cemented by iron or lime, is encountered within the 3-foot section. The surface soil is derived from the superficial material covering the higher plateaus of the region, consisting probably of stream or sheet flood outwash deposits from a variety of rocks. The cherty subsoils are derived from the cherty limestone formation underlying this stratum. The fragments have been disseminated throughout the soil by erosion and the translocating action of frosts and thaws. The type occupies a topographic position intermediate between the Lebanon silt loam and the Clarksville soils which are derived wholly from the cherty lime-

stone. The area covered was originally prairie, but now supports a growth of blackjack oak, with some post and black oak. Little of this type is used for agricultural purposes. By removing the stones the smoother areas could be used for shallow-rooted grain and grass crops.

Area and distribution of the stony loam.

Soil name.	State or area.[1]	Acres.
Lebanon stony loam	Missouri 11	6,272

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase of the loam group is represented by one soil type occurring under the Colorado series. It is not extensive and has been found only along the western edge of the Great Plains region.

Owing to the gravel content and the dominant sloping and frequently eroded and dissected topography, drainage is rather excessive. The rainfall is generally insufficient for crop production without irrigation and a great part of the area covered by the gravelly loam occupied is so elevated that irrigation is impracticable.

The soil is friable under cultivation, and where capable of irrigation it is adapted to the production of apples and other tree fruits, cereals, alfalfa, and sugar beets. It is better adapted to fruits and possesses a somewhat wider range in crop adaptation than the soils of the loam group so far as they have been encountered. It is rather inferior to the loams for heavy general farming.

Colorado gravelly loam.—The soil of this type consists of a gray to dark-colored heavy, silty fine sandy loam or loam, generally 6 feet or more in depth. It carries a large amount of gravel, which consists of fragments of granite, shale, or sandstone ranging in size from 5 or 6 inches in diameter, and increasing in quantity as the mountains are approached. The soil erodes easily, and in arroyos or cuts the subsoil often has a compact, adobelike structure. The type is formed largely of colluvial material. It occurs along mountain footslopes, and frequently as pronounced hills and ridges. It usually occupies elevations above the limits of irrigation. The soil is well drained and free from alkali.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Colorado gravelly loam	Colorado 2	33,408

[1] For key to number in this column see p. 733.

SILT LOAM GROUP.

The soils of the silt loam group are represented under a number of soil series and vary widely in location, extent, climate, topography, and crop adaptation.

Some of the members are frequently eroded and dissected and their topography is rough and broken. In one of the soils of the group a hardpan, impenetrable to plant roots, occurs at shallow depths, so that the type is not well adapted to other than shallow-rooted crops. In general, the topography is comparatively level to rolling, the soil and subsoil material of good depth, and the soil well adapted to agriculture with favorable moisture supply. The rainfall is usually light, but the soils, while somewhat sticky when wet, are of friable structure and are retentive of moisture under cultivation. Drainage is well established, but seldom excessive, and the character of the surface is such as to favor the use of farm machinery.

A great part of the areas covered is not extensively utilized for agriculture and is devoted mainly to grazing. Wheat, corn, kafir, sorghum, and flax are the principal crops of cultivated areas.

In general, where the climate is favorable, the silt loams are well adapted to general farming. They require a rather heavy farming equipment and in adaptation to crops do not depart greatly from the soils of the loam group.

Ashland silt loam.—The soil consists of a light to dark brown friable silt loam with an average depth of 12 inches. The subsoil is a yellowish brown to dark brown silty clay loam, which becomes more compact with depth and shows occasional streaks of calcareous material below a depth of 2 feet. The type occupies terraces in valleys which have probably been formed in part by the subsidence of the underlying rocks, owing to removal of overlying material by solution. The soil is derived mainly from local alluvial slope or outwash material distributed by surface waters and by minor streams and derived from the sandstone, shale, and limestone rocks of the Tertiary formations. Drainage is well established. The type is a good soil for general farming, wheat, corn, and kafir being the principal crops.

Lebanon silt loam.—The type consists of a brownish-gray to grayish-brown friable silt loam from 6 to 10 inches deep, underlain by a yellow or brownish yellow silty clay loam, which grades quickly into a plastic, tough clay of a yellowish-brown to chocolate-brown color. This in turn is underlain at an average depth of 24 inches by a more friable layer of mottled gray and yellow or bluish gray and pale yellow silty clay loam.

A tough "hardpan," consisting chiefly of angular chert fragments, often firmly cemented with lime or iron and having a mottled red and grayish appearance, is usually reached within the 3-foot section, generally at about 30 inches. The upper section of the subsoil is not everywhere present, but the tough, plastic clay stratum is always encountered. This clay when worked in wet condition hardens on drying into an impervious, intractable mass. Chert fragments are practically absent to a depth of 22 to 28 inches. The topography is flat to undulating, the type standing above the soils of associated series. The soil, excepting the lower cherty hardpan portion, is derived from a chert-free layer of material, whose origin is obscure, but which consists probably of outwash deposits of streams or of sheet surface waters, derived from a variety of rocks, the crystalline probably predominating. Where erosion has removed this surficial layer the cherty soils derived from underlying cherty limestone are encountered, the "hardpan" substratum sometimes being near the surface. This type is best suited to shallow-rooted crops such as grass and grain and is of fair agricultural value. It is readily improved by the addition of organic matter and a rotation of crops to include the legumes. Phosphatic fertilizers also give good results. The soil was originally prairie, except for a scattered growth of blackjack oak, but with the discontinuance of burning over the land for grazing the unused areas have become covered with trees.

Richfield silt loam.—The soil is a grayish-brown or dark-brown silt loam, with an average depth of 12 inches and containing some fine sand in the first 8 or 10 inches. The upper subsoil is a brown silty clay loam from 6 to 14 inches thick and is underlain by a grayish-yellow, calcareous, more silty loam, which extends to more than 3 feet. The topography ranges from almost level to sharply rolling. The type represents the weathered product of the unconsolidated or slightly cemented calcareous Tertiary material known as Plains Marl, derived predominantly from crystalline rocks of the Rocky Mountains and distributed by aggrading streams as alluvial-fan or foot-slope material modified by winds. Drainage is well established. The soil is productive under favorable conditions. Wheat, kafir, and some corn are grown.

Rosebud silt loam.—The surface soil to an average depth of 10 inches consists of a loose, friable, light silt loam ranging in color from light ashy gray to dark brown. The color of the soil is largely influenced in its darker shades by the content of organic matter. The subsoil consists of a light-gray to brown silt loam about 2 feet deep, the clay content being ordinarily greater than in the surface soil. This in turn is underlain by a white, light pink, or buff colored, calcareous, silty loam, which continues to a depth of several feet. Drainage is well established and the material is easily eroded. White eroded spots and incipient "bad lands" occur on slopes and hillsides. This type is derived from the unconsolidated, very calcareous Tertiary deposits formed mainly from sandstone and shale rocks, with some granitic material distributed as extensive alluvial-fan or foot-slope deposits by aggrading streams. The surface varies from almost level plains to rough hills and broken country approaching the "bad lands." Very little of this type has been placed under cultivation, but where moisture conditions are favorable it should prove an excellent soil for general farming. It is utilized mainly for grazing and for the production of corn, small grains, and flax.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Rosebud silt loam	Nebraska 7; South Dakota 3	3,919,104
Richfield silt loam	Kansas 10	3,369,088
Lebanon silt loam	Missouri 8, 11	102,080
Ashland silt loam	Kansas 10	13,824
Total		7,404,096

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The soils of the clay loam group in this province are not of extensive or frequent occurrence and have been recognized under two soil series only.

They have heavy, compact subsoils, the material of the deeper section being in part of residual origin and derived from underlying shales, sandstones, and limestones. They are confined to local flats, basinlike depressions in upland plains or prairies, or the base of adjacent hill slopes. Drainage is usually poor, and in many cases the reclamation of the land is impracticable within a reasonable limit of expense. In the more western semiarid areas alkali salts are sometimes present in injurious amounts in the more poorly drained areas.

The soils of the group are utilized mainly for pasture, and in agricultural importance are inferior to the loams and silt loams. Artificial drainage is usually required and careful management is necessary before they can be brought into a favorable condition of tilth. With good drainage and proper cultivation they are adapted to heavy general farming, including the production of cereals, sorghum and other forage crops, alfalfa, and grass crops.

Colorado clay loam.—The type consists of a dark reddish brown, compact, tenacious clay loam of adobe structure, generally 6 feet or more in depth. The type occupies depressions and lower slopes of local closed drainage basins in elevated treeless plains. The material consists of finer Tertiary foot-slope deposits, modified by further weathering and alluvial wash or sedimentation. Small flakes or granules of gypsum are frequently encountered. The topography is nearly level and unmarked by terrace or bluff lines or rock outcrop and the surface is free of gravel. The soil is generally poorly drained and shows traces of alkali.

Sedgwick clay loam.—The soil is a fine-grained silty loam, 12 to 18 inches deep, underlain by a bluish-gray to drab, tough, heavy, and compact clay, extending to a depth of 3 feet or more. The type occupies flat or depressed areas on upland prairies or occurs at the base of footslopes. It is poorly drained. The material represents alluvial depositions by minor streams or sheet floods from the surrounding soils and laid down as alluvial fan or slope material. The deeper subsoils are in places residual from sandstone, shale, and limestone material. The type is generally used for pasturage, although with thorough drainage it should be well adapted to wheat and corn.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Sedgwick clay loam	Kansas 11; Missouri 3	8,064
Colorado clay loam	Colorado 3	832
Total		8,896

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The sandy clay-loam soils are not of frequent occurrence in this province and have been recognized only under the Pratt series, the normal clay-loam member of which has not as yet been encountered.

In this soil the sand content is sufficiently high to alter the structure and texture of the soil, the material being somewhat more friable than the clay loams. With favorable moisture content the soil resembles sandy loams in texture. It is, however, sticky when wet and is retentive of moisture. The subsoil is compact and, unlike the clay loams, the soils usually have good drainage. The soil is well adapted to general farming. It does not demand as heavy farming equipment as the soils of clay-loam texture, and is superior to those soils in the Province in general agricultural importance and adaptability to farm crops.

Pratt sandy clay loam.—The type consists of a dark-brown sandy clay loam from 8 to 12 inches deep, overlying a subsoil of dark-brown or dark reddish brown compact sandy clay or sandy clay loam. When worked under favorable conditions of moisture the texture is similar to that of a sandy loam, yet the content of clay is nearly high enough to make the soil a clay loam. The topography is rolling to undulating, and drainage ordinarily well established. The type is derived from unconsolidated Tertiary deposits originating mainly from feldspar-bearing crystalline rocks and distributed by aggrading streams as broad alluvial mountain footslope or alluvial plain deposits. A proper moisture supply is easily maintained, and crop yields are good.

Area and distribution of the sandy clay loam.

Soil name.	State or area.[1]	Acres.
Pratt sandy clay loam	Kansas 6	1,408

[1] For key to number in this column see p. 733.

SILTY CLAY LOAM PHASE.

The soils of the silty clay loam phase in this province are much more extensive and of greater agricultural importance than the normal clay loams. They have been encountered under four important soil series which are widely developed in the middle western and southwestern sections of the Great Plains region. In none of these series in which the silty clay loam appears has the clay-loam member been recognized, the soil-forming agencies having apparently favored the accumulation of a large amount of silt particles with the clay and sandy material.

The soil is rather heavy and tenacious when wet, with a tendency to puddle and became intractable if cultivated while too wet. Where well drained and carefully cultivated it is mellow and friable. The subsoil is rather compact, often calcareous, and possesses pronounced water-holding power, rendering the soil retentive of moisture and well adapted to agriculture, even with the prevailing light rainfall, if judiciously managed. The topography is level to gently undulating and favorable to the extensive use of farm machinery. Drainage is ordinarily well established, but in places deficient.

The silty clay loams are adapted to a heavy type of general farming, except in areas where the climate may be entirely unsuitable. They are utilized mainly for grazing and for the production of small grains, corn, alfalfa, kafir, sorghum, milo, and similar crops. A heavy farming equipment is required.

Amarillo silty clay loam.—The surface soil is from 2 to 8 inches deep, and consists of a brown or chocolate-brown silty clay loam which, in many places, has a slightly reddish tinge. It is underlain by a compact reddish-brown silty clay loam, which extends to a depth of 18 to 24 inches and rests upon a white, calcareous material, which merges into a white, calcareous substratum at a depth of 4 or 5 feet. The topography is gently undulating to rolling. The type has been formed by the weathering of the heavier unconsolidated Tertiary deposits derived from both sedimentary and crystalline rocks and deposited as broad alluvial outwash plain or fan material by former aggrading streams. The red color is probably due to an admixture of material from the Permian Red Beds. The type is well adapted to sorghum, kaffir, milo, wheat, and oats. It is a strong, productive soil, but yields are largely dependent on climate. It is utilized principally for grazing and the production of forage crops and small grains.

Fowler silty clay loam.—The soil consists of a dark-brown to black heavy silty loam from 12 to 16 inches deep. The subsoil is a light-brown to dark-brown silty clay loam to a depth of 30 inches, below which a white or mottled calca-

reous material is encountered. The surface is nearly level and drainage is rather poor, owing to insufficient slope and an impervious subsoil. The type occupies basins or valleys formed by subsidence resulting from the removal of underlying gypsum or salt-bearing rock by solution. The soil is derived from the Tertiary deposits consisting mainly of wash from crystalline rocks with some sandstone, limestone, and shale laid down as outwash-plain material and locally modified by the addition of alluvium from streams. The type is subirrigated and produces good crops, of which alfalfa is the most valuable. Corn, wheat, and the sorghums are also grown.

Pratt silty clay loam.—The surface soil is a dark-brown silty clay loam about 10 inches in depth, and is underlain by a dark-brown to reddish-brown heavy silty clay loam or clay which is sticky when wet but under favorable moisture conditions works readily into a good tilth. The topography is rolling to undulating, and the type has fair to good drainage. The soil is derived through the weathering of the finer-textured material of the unconsolidated Tertiary formations derived mainly from crystalline rocks and deposited as extensive areas of mountain footslopes or alluvial fans by aggrading streams. The soil is very productive, and with sufficient rainfall good yields of sorghum, kafir, milo, wheat, oats, etc., can be secured.

Richfield silty clay loam.—This type consists of a dark, grayish-brown to nearly black silty clay loam from 8 to 16 inches deep, and of compact structure but friable under cultivation. The subsoil is a light or grayish-brown silty clay loam or silty clay of rather compact structure, at a depth of 2 to 3 feet becoming lighter in color and strongly calcareous. The topography is nearly level or gently undulating, but the type is usually fairly well drained. It has been formed by the weathering of unconsolidated or partially cemented Tertiary material derived mainly from crystalline rocks and deposited as extensive areas of mountain foot-slope or alluvial fan material by aggrading streams. The soil is very productive and with sufficient rainfall good yields of sorghum, kafir, milo, wheat, oats, etc., can be grown.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Amarillo silty clay loam	Texas 22	6,324,480
Richfield silty clay loam	Kansas 10; Texas 22	1,161,216
Fowler silty clay loam	Kansas 10	41,472
Pratt silty clay loam	Kansas 6	23,424
Total		7,550,592

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

Only one soil type has been encountered under the clay group within this province.

This soil is extremely tenacious and refractory, becoming sticky when wet and baking and checking upon subsequent exposure. The texture and structure of both soil and subsoil and the predominant topography are unfavorable to drainage, and alkali salts are often present in injurious amounts.

The type is inextensive and rather local in occurrence and is not utilized to any extent, except for pasture. It occurs in semiarid regions, and if properly drained and irrigated could be utilized for the production of grain and hay crops. It is adapted only to a heavy type of general farming and requires the heaviest of farming equipment and extremely careful management.

Orman clay.—The soil is a grayish-brown to dark-brown, extremely heavy, tenacious, and compact clay. It is refractory in structure, readily puddled, and bakes and cracks upon drying. The subsoil is grayish-brown to drab and similar to the soil in texture and structure. It occupies flats and gently inclined hill slopes and is poorly drained. It consists of fine material derived from shales, deposited as alluvial slope or fan material by sheet wash or intermittent streams, some of which has been deposited in shallow waters of temporary lakes. Alkali is generally present throughout the soil in considerable quantities. The type is not at present utilized for agricultural purposes to any extent, except for grazing. Under favorable irrigation and drainage conditions the type is adapted to small grains and alfalfa.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Orman clay	South Dakota 3	327,168

[1] For key to number in this column see p. 733.

RIVER FLOOD PLAIN MATERIAL.

The alluvial deposits of the River Flood Plains and Terraces are widely distributed in the Great Plains region. They frequently occur along the numerous drainage courses in the more humid middle and southeastern parts of the region, but are most extensive and typically developed in the wide, shallow valleys of the larger streams having their sources in the Rocky Mountains and traversing the region in an easterly and southeasterly direction. The more important areas include the valleys of the Missouri, the Platte, the Arkansas, the Canadian, and the Rio Grande Rivers and their tributaries.

The transportation and deposition of large amounts of alluvial material from running water are particularly significant factors here in soil formation. They result from the seasonal fluctuations in stream flow, the pronounced decrease in volume of flow from seepage, the susceptibility of the rocks encountered in the course of the stream tributaries to erosion, and in the sudden violent storms of the regions adjoining the Rocky Mountains where the streams head.

Most of the soils of the province include material derived from both the quartz-bearing crystalline rocks, transported from the Rocky Mountains or represented in unconsolidated Tertiary deposits of the Plains, and from the sandstones, shales, and limestones of the plains and prairies. This dominant soil group is represented by the Laurel, Arkansas, Cheyenne, Lancaster, and related series. They usually vary widely in drainage conditions, frequency of overflow, and in character of underlying material. Some of the soils are poorly drained, as is the case with the Bassett series. Others, such as those of the Arkansas series, are marked by the occurrence of a porous substratum of gravels and sands within the usual depth of the soil section.

In some cases, particularly along streams tributary to the larger rivers and heading in areas of sedimentary rocks of the prairies and plains, the material is derived wholly or predominantly from sedimentary rocks. This is represented by the soils of the Wade series, which consist mainly of shale and sandstone material.

Other areas of alluvial soils which are rather local in extent occur along minor streams traversing the areas of loessial deposits within the Great Plains region. These are represented by the soils of the Osgood series, whose constituent sediments have been derived from the erosion of loessial deposits.

The soils of the River Flood Plains and River Terrace materials in the Great Plains region cover much less extensive areas than do those derived from the Residual and Outwash Plain materials. They are, however, better watered and are more conveniently situated with regard to water supply for irrigation. Moreover, the stream valleys are in many cases followed by the railways because of their natural low grades, so that transportation is convenient, and the larger towns and cities of the Great Plains region are located within these areas, where the bulk of the intensively cultivated products of high market value are grown.

DESCRIPTION OF THE SOIL SERIES.

Arkansas Series.—The series includes grayish-brown or dark-brown soils with yellow and yellowish-brown subsoils, resting upon a deep substratum of gravels and sands extending to a depth of many feet. The substratum is sometimes so near to the surface as to cause the soils to be deficient in moisture-retaining capacity and somewhat droughty, though on the other hand this reservoir of sands and gravels is generally subirrigated by seepage waters from streams. The soils are alluvial in origin, having been deposited by the larger streams in the central prairie region, and are derived from material of crystalline rocks of Tertiary age transported from the Rocky Mountains, and in part from shales, sandstones, and limestones of the Plains region. The surface is level to undu-

lating. Drainage is generally fair, but is deficient locally, or the soils may be subject to overflow. The soils are generally productive. Wheat, corn, forage crops, and alfalfa are the principal crops.

Area and distribution of the soils of the Arkansas series.

Soil name.	State or area.[1]	Acres.
Arkansas sand	Kansas 11	19,392
fine sand	Kansas 6, 7, 11	22,336
fine sandy loam	Kansas 6, 7, 10; Missouri 1	132,800
loam	Kansas 6, 11	69,696
silt loam	Kansas 7	17,600
clay loam	Kansas 6	11,072
clay	do	1,152
undifferentiated	Nebraska 1[2], 7	326,528
Total		600,576

[1] For key to numbers in this column see p. 733.
[2] Part of Grand Island area outside the reconnoissance survey.

Bassett series.—The soils are dark gray to brown, with gray or lighter brown, rather heavy and compact subsoils. At a depth of 3 to 5 feet a light ashy-gray or white impervious clay is encountered. The members of the series are of alluvial origin, derived from crystalline, shale, and sandstone rocks and deposited by streams over river flood plains and terraces. They occupy level or depressed areas and are poorly drained. They produce wild hay of good quality, and owing to their poor drainage are best adapted to this purpose.

Area and distribution of the soil of the Bassett series.

Soil name.	State or area.[1]	Acres.
Bassett silty clay	Nebraska 7	64,512

[1] For key to number in this column see p. 733.

Cheyenne series.—The soils are brown, with lighter brown or yellow subsoils, underlain by a substratum of porous sands and gravels. The soils of this series consist of alluvial stream deposits occupying high valley terraces, laid down in Pleistocene times, while the streams were choked by glacial ice. They are usually well drained, and where the underlying gravel does not too closely approach the surface they are productive and adapted to grazing, small grains, corn, and potatoes. Under irrigation they are also adapted to alfalfa, fruits, and the lighter members to truck crops.

Area and distribution of the soil of the Cheyenne series.

Soil name.	State or area.[1]	Acres.
Cheyenne undifferentiated	South Dakota 3	311,040

[1] For key to number in this column see p. 733.

Laurel series.—The soils of this series are dark gray to brown. The subsoils are usually lighter in color and are generally underlain by a porous gravel substratum. As a rule, the underdrainage is good. On the heavier types the surface drainage is in places deficient. The topography is flat to gently undulating. The series occurs in the river valleys as recent and older alluvial or terrace deposits along streams. Lower lying bodies are sometimes subject to overflow. The soils are utilized for a wide range of crops, including corn, small grains, forage, melons, cantaloupes, and vegetables and sugar beets.

Area and distribution of the soils of the Laurel series.

Soil name.	State or area.[1]	Acres.
Laurel fine sand	Colorado 3; Nebraska 5	11,392
sandy loam	Colorado 2; Montana 1	42,624
fine sandy loam	Nebraska 5	5,760
loam	Colorado 3	37,760
undifferentiated	Kansas 10; Nebraska 7	720,960
Total		818,496

[1] For key to numbers in this column see p. 733.

Lincoln series.—The soils are similar to those of the Arkansas series. being dark-brown to dark-gray or nearly black. The subsoils are somewhat heavier and more compact than those of the Arkansas series, particularly in the deeper areas. They are dark-gray to brown, and the underlying beds of gravel are usually absent. They are therefore, as a rule, more retentive of moisture and less likely to be droughty than the Arkansas soils. Drainage is usually well established. The soils are of alluvial origin and are confined to the bottoms and terraces of small tributary streams in the central-western prairie region. They are derived mainly from unconsolidated or soft, partially cemented Tertiary deposits. representing mainly crystalline rocks, shales, sandstones, and limestones. Corn, forage crops, small grains, and alfalfa are the principal crops.

Area and distribution of the soils of the Lincoln series.

Soil name.	State or area.[1]	Acres.
Lincoln fine sand	Kansas 6	1,600
sandy loam	do	6,272
fine sandy loam	do	16,320
very fine sandy loam	do	5,120
loam	do	2,560
clay loam	do	1,536
undifferentiated	Kansas 10; Nebraska 7	2,271,744
Total		2,305,152

[1] For key to numbers in this column see p. 733.

Osgood series.—The soils are light-brown to brown and range in depth from 12 to 18 inches. The subsoils consist of grayish-yellow. friable, fine sandy loam of silty texture. The series occupies low second terraces in stream valleys. The topography is nearly level, but the soils are not subject to overflow and are usually well drained. The material is of alluvial origin and derived from near-by loessial soils. They are generally free from alkali salts and are devoted to corn, small grains, alfalfa, and sugar beets.

Area and distribution of the soil of the Osgood series.

Soil name.	State or area.[1]	Acres.
Osgood fine sandy loam	Nebraska 4	16,320

[1] For key to number in this column see p. 733.

Tripp series.—The surface soils are brown to light gray, the surface frequently having an ashy gray appearance. The subsoils are light gray to white. The series is of alluvial origin and occupies stream bottoms and terraces. It is derived from crystalline, sandstone, shale, and probably calcareous rocks, modified in places by wind-laid material. The topography is comparatively level and erosion is active. Drainage is usually fairly well established. The members of the series are generally irrigable and with favorable climate they are adapted to corn, wheat, oats, potatoes, vegetables, etc.

Area and distribution of the soils of the Tripp series.

Soil name.	State or area.[1]	Acres.
Tripp loamy fine sand	Nebraska 7	82,944
very fine sandy loam	do	304,128
loam	do	87,552
silt loam	Nebraska 7; South Dakota 3	142,848
Total		617,472

[1] For key to numbers in this column see p. 733.

Vale series.—The soils are reddish-brown. The subsoils are usually similar to the soils, but are sometimes compact and vary from dark to light reddish-brown with yellowish brown streaks. The series occupies benches or terraces and slopes and stream bottoms. The material is of alluvial origin and is derived from crystalline rocks, including granite, gneiss, and schist, and from shales and sandstones, the latter comprising the red gypsum-bearing rocks of the Permian Red Beds. The soils often contain large quantities of organic matter and are generally free from alkali. The surface varies from gently sloping or level to rough and broken or dissected. The members of the series are usually well drained and free from overflow. They are used for grains, alfalfa, corn, and tree fruits, both with and without irrigation.

Area and distribution of the soils of the Vale series.

Soil name.	State or area.[1]	Acres.
Vale gravelly sandy loam	South Dakota 1	2,304
fine sandy loam	do	23,936
loam	do	3,520
Total		29,760

[1] For key to number in this column see p. 733.

Wade series.—The soils are brown to dark gray, drab, or dark brown. In the northern areas the immediate surface carries large amounts of organic matter and is often black when moist. The subsoils are light brown, brown, or gray to dark drab, rather heavy and compact, and frequently calcareous. They occupy bottoms and terraces of stream valleys. They are of alluvial origin and derived from the erosion of sandstone, limestone, and shales. The surface varies from level to sloping, and some of the members are poorly drained and subject to occasional overflow or to accumulations of alkali salts. A growth of cottonwood, box elder, ash, and elm is often found in the vicinity of stream courses. The soils are well adapted to general farming under irrigation or with sufficient rainfall. The principal crops are corn, small grain, flax, potatoes, and, where well drained, alfalfa. In the irrigated districts sugar beets are an important product.

Area and distribution of the soils of the Wade series.

Soil name.	State or area.[1]	Acres.
Wade fine sandy loam	Montana 1; North Dakota 7; South Dakota 3	249,664
loam	Colorado 2; North Dakota 7; South Dakota 3	285,568
gravelly loam	Montana 1	11,776
silt loam	Colorado 2; North Dakota 6, 7	32,384
clay loam	Colorado 2; Montana 1	26,944
clay	Colorado 3; Montana 1; North Dakota 6, 7	29,440
undifferentiated	South Dakota 3	78,336
Total		714,112

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

The sand group of the River Flood Plains province in the Great Plains region includes but one member, which has been recognized under the Arkansas series.

The subsoil is coarse and porous, and underdrainage is somewhat excessive. The topography is level to somewhat irregular and broken by dunes, resulting from drifting soil. There is moderate rainfall and the location of the type is favorable to subirrigation from adjacent streams. Owing to these modifying factors, the soil is superior in productiveness and in adaptation to general farm crops to the ordinary soils of the sand group. Corn, alfalfa, and forage crops are grown with good results, and where transportation facilities and markets are good melons, early fruits, and truck crops can be profitably grown.

Arkansas sand.—The soil to a depth of 12 or 14 inches consists of a yellowish-brown, porous medium sand. The subsoil is a reddish-yellow, rather loose sand, coarser than the soil and largely composed of fragments of feldspar and quartz. A substratum of gravel and sand is frequently encountered at 4 to 6 feet. The type occurs upon stream terraces and bottoms. Drainage is usually well established. The surface configuration in many places is interrupted by dunelike hillocks of wind-blown sand, varying in height from 2 to 5 feet. This is an alluvial soil containing considerable material from the eastern slopes of the Rocky Mountain region derived from crystalline rocks and from unconsolidated Tertiary deposits, with an admixture of materials from sandstone, shales, and limestones. Corn, alfalfa, and fruit give good results, and the type is well adapted to melons and early truck crops.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Arkansas sand	Kansas 11	19,392

[1] For key to number in this column see p. 733.

Fine Sand Group.

The fine sands of the Alluvial Flood Plain and Terrace soils in the Great Plains region are represented in two important soil series.

The soil areas usually occur in the immediate vicinity of stream channels, and the surface is frequently wind-blown, marked by remnants of former stream channels, or dissected by erosion. A heavy growth of timber and willows or other undergrowth is a general characteristic.

The soils of the group are generally underlain by a porous gravelly substratum, making underdrainage excessive except in low-lying areas subject to the occurrence of a high water table. These lower lying bodies are also frequently overflowed during periods of flood. The soils of the group are not extensively cultivated, but where free from overflow and capable of irrigation, or where natural moisture conditions are favorable, they are devoted to some extent to the production of corn, alfalfa, kafir, sorghum, and to peaches, apples, and other fruits, melons, and truck crops. They require but a light farming equipment, but must be carefully cultivated, owing to their low moisture-retaining power and to the tendency of the soil to drift where not protected by windbreaks or vegetation.

The soils of this group are slightly superior for general purposes to the sand group of the province under similar conditions of moisture supply. Where wind-blown but free from overflow, and where the water table is not too near the surface, they are best utilized for alfalfa or similar cover crops. Under favorable conditions of moisture and drainage, and where protected from overflow and wind drifting, they are best adapted to the production of early stone fruits, small fruits, melons, and truck crops. In adaptation to the general farm crops they are inferior to the heavier soils.

Arkansas fine sand.—The type consists of a grayish-brown to light-brown fine sand from 12 to 18 inches in depth, underlain by a yellow or yellowish-brown fine sand continuing to a depth of 36 inches or more, where a substratum of

porous sand and gravel is encountered. The topography varies from nearly level to irregular and broken by dunes, and drainage is excessive. The type is formed by sediments recently deposited by streams, and some of it is but slightly elevated above the stream channel and subject to overflow during floods. It drifts badly in heavy winds if not protected by breaks. Where it can be protected from overflow and winds, corn, kafir, sorghum, melons, truck crops, and peaches, apples, and other fruits are grown to some extent.

Laurel fine sand.—The soil is a micaceous fine sand of light-gray to reddish-brown color and loose, porous structure. It varies from 1 to 6 feet or more in depth and is underlain by coarser river sands and gravels or sometimes by heavier alluvial deposits. The type frequently occurs in long, narrow bodies covering river flood plains and lower stream terraces. It is often cut by sloughs, stream channels, or depressions and slight ridges, and is subject to overflow. The soil consists of recent stream deposits, and generally varies widely in texture and structure. It supports a strong growth of willows and cottonwood. The type is sometimes used for alfalfa and truck crops.

Lincoln fine sand.—The surface soil consists of a gray or light-brown fine sand from 12 to 15 inches deep, and is underlain by a yellow or brown fine sand. Both soil and subsoil are rather incoherent and the surface is more or less subject to drifting. The type is alluvial in origin and occurs along comparatively small streams where it is subject to occasional overflow. The topography is level to gently undulating. In some areas small dunes have been formed by wind action. On account of the natural porosity of the subsoil the underdrainage is good. The type is rather low in agricultural value, producing moderate yields of corn, kafir, and sorghum. It is also well adapted to such truck crops as melons, cantaloupes, and berries.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Arkansas fine sand	Kansas 6, 7, 11	22,336
Laurel fine sand	Colorado 3; Nebraska 5	11,392
Lincoln fine sand	Kansas 6	1,600
Total		35,328

[1] For key to numbers in this column see p. 733.

LOAMY FINE SAND PHASE.

The loamy fine sand has been encountered under but one soil series in this province.

Both soil and subsoil are open and porous, but noticeably coherent when moist and of distinctly loamy texture. The soil is subject to semiarid conditions, is low in organic matter, well drained, and not very retentive of moisture.

Where capable of irrigation, however, or where the rainfall is sufficient, it is utilized for the production of cereals, potatoes, and alfalfa. Where not cultivated it is used for grazing. Under similar conditions of moisture and drainage, exposure, etc., it is slightly better adapted to general farming, fruit, and truck crops than the soils of the fine sand group. It is best used for cover crops, owing to danger from wind drifting.

Tripp loamy fine sand.—The soil is a yellowish-gray open sand which drifts badly under cultivation. The subsoil is similar in color, texture, and structure to the soil. The surface is level to gently undulating, with occasional irregularities, and is generally well suited to irrigation. The type is of residual origin and derived from crystalline shale and sandstone rock, much of which has been transported long distances from mountain areas or from areas of unconsolidated Tertiary deposits covering portions of the Great Plains. It occupies old stream terraces lying well above the present flood plains, and has been largely modified by winds. It is low in organic matter. The type is utilized for grazing and for the production of small grains, alfalfa, potatoes, etc. It is not well adapted to intertilled crops owing to danger from wind drifting.

Area and distribution of the loamy fine sand.

Soil name.	State or area.[1]	Acres.
Tripp loamy fine sand	Nebraska 7	82,944

[1] For key to number in this column see p. 733.

SANDY LOAM GROUP.

The sandy loams of this province are not extensive, but are quite widely distributed. They have been recognized under two soil series.

One of the members is marked by the occurrence of a porous gravelly substratum, the other by a subsoil which is usually heavier and more compact than the surface material. The two soils vary in climate, drainage, possibilities of irrigation, and crop adaptation. The soils are utilized mainly for the production of corn, kafir, sorghum, and other forage crops, and to some extent for cereals and vegetables. They are better suited to general farming than the soils of the groups in this province described above, but are most suitable for a rather light type of farming and for the culture of truck crops. They are usually deficient in organic matter, and like the lighter soils of the province require frequent applications of organic manures for the maintenance of productiveness. They require only a light farming equipment.

Laurel sandy loam.—The soil is a light-yellow to black alluvial sandy loam, from 2 to 6 feet deep, and is underlain by water-worn gravel and sand. The surface is usually level and marked by sloughs, old river channels, and swampy areas due to seepage from irrigation ditches. Except where affected by alkali the soil is excellent for vegetables and fruits.

Lincoln sandy loam.—This is a dark-brown to dark-gray sandy loam about 12 inches in depth. It is loose and slightly incoherent in structure and is underlain by a loamy sand or heavy sandy loam, more or less mottled with gray and yellow. The topography is level to slightly sloping, the type occurring in small stream valleys where the material has been deposited by stream action during periods of flood. It is derived mainly from Tertiary deposits of the Great Plains, predominantly from crystalline rocks. Some material from shale, sandstone, and limestone formations is included in the soil mass. Drainage is well established. The type is utilized for corn, kafir, and sorghum, and occasionally for other staple farm crops, although owing to its light texture yields are usually low.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Laurel sandy loam	Colorado 2; Montana 1	42,624
Lincoln sandy loam	Kansas 6	6,272
Total		48,896

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam phase of the sandy loam group in this province is represented by a single member.

It occurs as stream terraces of uneven surface and on slopes and local elevations. The high content of gravel renders the soil open and porous in structure, while owing to its physiographic position drainage is thorough and usually excessive. Much of the type has a rough topography. The rainfall is light, and the soil is deficient in moisture-retaining capacity. It is generally utilized for grazing, but where irrigated and favored by local climate and topography would probably be suitable for the production of early tree fruits.

It has been recognized only in small areas, and constitutes an unimportant phase of the sandy loam group. It is inferior to the sandy loams in agricultural possibilities, and departs widely from them in adaptation to crops.

Vale gravelly sandy loam.—The type consists of a light reddish-brown coarse sandy loam or fine sandy loam, which contains varying quantities of water-worn gravel, ranging in size to 4 or 5 inches in diameter, the quantity usually increasing with depth. The sandy surface material is usually underlain at depths below 3 feet by a reddish-brown subsoil of finer and more compact material. It is found on old river terraces marking former stream flood plains, and has an uneven surface and frequently precipitous terrace margin. The type was formed by material brought down by the streams and derived from granite, gneiss, and schist, with an admixture of material derived from red shales and sandstones. Except for pasture this soil is not extensively utilized because of its uneven topography and low moisture-retaining power. Under irrigation and with favorable climate it is adapted to fruits.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Vale gravelly sandy loam	Souch Dakota 1	2,304

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams constitute one of the most extensive and important soil groups of the River Flood Plains province in the Great Plains region. The members of this group have been recognized under a number of important soil series and are widely distributed over the northern, middle, and western sections of the region.

They are subject to a wide range with regard to drainage, overflow, and possibilities of irrigation. The character of underlying material is also subject to some variation. In the eastern part of the region the average annual rainfall is generally sufficient for agriculture, but in the western areas irrigation is generally necessary except in lower lying soils which receive moisture by subirrigation from streams.

In the river bottoms and on the lower terraces the soils are frequently overflowed, but for the most part they are free from overflow and are well drained. The soil material is usually rather porous and friable, rarely puddles, and readily becomes mellow and friable under cultivation. It is less porous and leachy than the soils of lighter texture, is superior in moisture-holding properties under cultivation, and is rarely disturbed to any serious extent by winds.

The fine sandy loams are good general-purpose soils and possess a wider range for producing profitable yields of both general farm crops and special intensely cultivated products than do most of the soils of the other groups. They are utilized for a variety of products, including wheat and other small grains, corn, sorghum, kafir, millet and similar forage crops, alfalfa, melons, cantaloupes and truck crops, including particularly cucumbers, cabbage, etc., potatoes, and sugar beets. Tree fruits, consisting of apples, cherries, plums, peaches, etc., are grown to some extent, but their production does not constitute an important industry. Speltz, millet, and flax are grown extensively in the northern areas.

The fine sandy loams require only a moderately expensive or heavy farming equipment, and when devoted to intensively cultivated products may be economically utilized in small tracts and brought to a high state of cultivation capable of supporting thickly settled rural communities. They are slightly less productive than the soils of heavier texture when devoted to heavy farming unless subject to a particularly effective adjustment of moisture supply. They are best adapted to a rather light type of general farming. Vegetables and fruits do better than upon the soils of lighter texture, but the lighter soil groups are somewhat better adapted to early stone fruits and vegetables. Sugar beets yield well where the moisture supply is favorable, and the sugar content is usually high. Heavier average yields are generally obtained from soils of heavier grade, though the sugar content is frequently lower.

Arkansas fine sandy loam.—The soil is a grayish-brown or yellowish-gray, porous, and frequently silty fine sandy loam from 10 to 18 inches deep. It is underlain by a yellow or yellowish-brown fine sand or silt, which extends to a depth of more than 3 feet. Scattered gravel occurs in both soil and subsoil, the quantity increasing with depth. The type is underlain by a substratum of sand and

river-laid gravels, which is not always encountered within the depth of 6 feet. The type is purely alluvial in origin, having been built up by stream deposits. It is derived from crystalline rock of the unconsolidated Tertiary deposits, or transported by present streams from the Rocky Mountains, modified by material from the sedimentary rocks of the Plains. It occupies valley bottoms and terraces. The surface is occasionally interrupted by low, wind-blown mounds and ridges. The type is usually well drained and but seldom subject to overflow. It is nearly all cultivated, and yields are good. Small grains, corn, melons, vegetables, and alfalfa are the principal crops. Subirrigation tends to check loss from drought, which is not so severe as on the upland soils. The type is well adapted to truck crops.

Laurel fine sandy loam.—The type consists of a light-gray to brown fine sandy loam varying in depth to 15 inches and resting on a lighter colored material which is slightly more sandy than the soil. The type occupies low, flat areas bordering streams, and is purely alluvial in origin. In places it is subject to overflow. It is generally well drained. The soil is adapted to potatoes, melons, cucumbers, cabbage, forage crops, corn, and alfalfa. Crops sometimes suffer from drought, owing to the loose, porous nature of the soil.

Lincoln fine sandy loam.—This type is a somewhat variable, dark-brown fine sandy loam about 15 inches deep, underlain by a brown to yellowish-brown fine sandy loam or sandy clay to a depth of 36 inches or more. The substratum of sands and gravels is lacking in this type. It occupies high first bottoms along small streams in the western prairie section, and is more or less subject to inundation. The type is of alluvial origin, and was formed principally from unconsolidated, granitic Tertiary material. Where the soil can be protected from overflow, or after the floods have subsided, it is well adapted to general farm crops and to vegetables.

Osgood fine sandy loam.—The soil is a light-brown to brown, silty fine sandy loam from 12 to 18 inches deep. The subsoil to a depth of 36 inches consists of a grayish-yellow very fine sandy loam or silt loam. The type is of alluvial origin, and consists of eroded loessial material which has been washed into the valleys, forming low, second-bottom terraces, with nearly level topography and well-developed drainage. Only in a few places does alkali occur in quantities injurious to crops. Corn, wheat, oats, alfalfa, sugar beets, brome grass, and fescue are important crops. Speltz is also grown to some extent. The type is particularly well adapted to alfalfa and sugar beets.

Vale fine sandy loam.—The soil is a reddish-brown fine sandy loam. The subsoil is light to dark reddish brown, and usually similar to the soil in texture, but in places it is a clay loam to a depth of 6 feet or more. It frequently contains thin layers of lighter material, usually a sandy loam. The type occupies high level benches, uniform slopes, and lowlands. It is an alluvial soil and owes its origin to deposition of red shale and sandstone material carried by streams draining the Black Hills. The soil is practically free from alkali. Dry farming and irrigation are both practiced, though irrigation gives more certain results. Alfalfa, corn, oats, wheat, and fruits do well.

Wade fine sandy loam.—The soil is a gray or dark-brown to drab fine sandy loam, high in organic matter. The subsoil is similar to the soil in texture and structure, but is lighter brown in color. The type occupies stream flood plains and terraces, and is of alluvial origin, derived mainly from sandstones and shales. It is sometimes subject to overflow, but drainage is usually well developed. It is utilized for grazing and for the production of oats, flax, millet, corn, and, to a less extent, for wheat. It is an excellent truck soil, and would probably produce good yields of alfalfa.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Wade fine sandy loam	Montana 1; North Dakota 7; South Dakota 3	249,664
Arkansas fine sandy loam	Kansas 6, 7, 10; Missouri, 1	132,800
Vale fine sandy loam	South Dakota 1	23,936
Osgood fine sandy loam	Nebraska 4	16,320
Lincoln fine sandy loam	Kansas 6	16,320
Laurel fine sandy loam	Nebraska 5	5,760
Total		444,800

[1] For key to numbers in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

The very fine sandy loam phase of the fine sandy loam group, so far as recognized, embraces only two members.

The surface topography is level to gently sloping and well adapted to irrigation. Drainage is generally well established. The soil material includes a greater amount of very fine sand than do the normal fine sandy loams of the province, which renders the soil slightly more coherent when moist and increases its moisture-holding power. The material of the deeper subsoil is lighter and more porous than the soil, and affords good underdrainage. The soil puddles if cultivated when too wet, but under favorable moisture conditions it is friable and mellow and requires only a moderate farming equipment in cultivation. The very fine sandy loams are better adapted to a moderately heavy type of general farming, and are slightly better suited to grains and hay or other general farm crops than are the fine sandy loams of the province. They are, however, much less extensive than the soils of the fine sandy loam group, and are not so well adapted to early truck crops. They are devoted mainly to general farm crops, including alfalfa, wheat, and other small grains, corn, and potatoes.

Lincoln very fine sandy loam.—The soil is a dark-brown, very fine sandy loam from 12 to 20 inches deep, and is underlain by a brown or yellowish very fine sandy loam, which grades into fine sand at a depth of 30 inches. The type is developed in small stream valleys in the central western prairie States. It is alluvial in origin and represents stream deposits derived mainly from the erosion of unconsolidated or partially cemented Tertiary deposits of the Great Plains region, originating predominantly from crystalline rocks. Some material derived from sedimentary rocks is probably included with the soil material. Drainage is usually well established. The type is fairly well adapted to alfalfa, wheat, and corn.

Tripp very fine sandy loam.—The soil is a light-brown very fine sandy loam. The subsoil is slightly lighter in texture than the soil material and of yellowish color. The surface varies from nearly level to rolling and is usually well adapted to irrigation. Drainage is fairly well established. The type is of alluvial origin and derived from crystalline rocks, shales, and sandstones. Part of this material has been transported long distances from mountain regions or from areas of unconsolidated Tertiary deposits in the Great Plains. It has been subsequently modified by the addition of wind-laid or alluvial stream outwash from adjacent sources. The type is adapted to small grains, and particularly to potatoes and alfalfa.

Area and distribution of the very fine sandy loam.

Soil name.	State or area.[1]	Acres.
Tripp very fine sandy loam	Nebraska 7	304,128
Lincoln very fine sandy loam	Kansas 6	5,120
Total		309,248

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The loam soils of the Alluvial Flood Plains and Terraces in the Great Plains region are represented under a number of soil series and constitute one of the most important soil groups of the region. They are extensively developed and widely distributed.

Like the fine sandy loams, the individual members vary in topographic position and in relation to drainage and irrigation, in character of underlying material and climate. Some of the members of the group are frequently subject to overflow or to poor drainage, while others are free from overflow and thoroughly drained. Some receive adequate rainfall, while others can be used only under irrigation. In certain localities the production of intensively cultivated crops, such as sugar beets, is favored by soil and climate, but owing to lack of transportation facilities or poor markets or to difficulty in procuring labor, the soil can be economically utilized only for grazing, stock raising, or

general farming. Some of the soils of the group are underlain by compact, impervious subsoils, others by a porous, gravelly substratum.

The loams are utilized mainly for general farming and for grazing. Wheat, oats, and other cereals, sorghum, kafir, and related crops, alfalfa, potatoes, and corn are the principal crops. In the western areas flax is grown to some extent, and in the irrigated districts sugar beets constitute an important product upon the loams of the Laurel and of the Wade series.

The soils are rather heavy and generally sticky when wet. They puddle and bake if cultivated while too wet, and require more careful management and more thorough cultivation than the soils of lighter texture. With sufficient moisture and careful cultivation they are friable and easily worked, and are retentive of moisture. They require a somewhat heavier farming equipment than the soils of the fine sandy loam group and are not adapted to as wide a range of crops.

They are suited to general farm crops and to the production of grains, alfalfa, forage crops, and sugar beets. Cantaloupes and vegetables, excluding those intended for early market, may be grown commercially. In the production of watermelons and early truck crops these soils are inferior to those of lighter texture.

Arkansas loam.—The soil is a dark-brown loam which becomes almost black when wet, and contains more or less fine sand. The subsoil is a brown compact loam or clay loam, resting upon beds of loose, yellowish sand and fine gravel, which occur at depths varying from 26 inches to a few feet and extend downward many feet. The presence of these beds of gravel sometimes causes the soils to be droughty, though in places they serve as reservoirs for water which has moved laterally from the channels of streams, and constitutes a source of supply for the use of crops. The topography is level to slightly undulating, the type occurring upon terraces, where the material has been deposited by streams during periods of flood. Drainage is fairly well established, but low-lying areas are sometimes subject to overflow. The material is derived mainly from crystalline rocks and transported from the Rocky Mountains or from areas occupied by unconsolidated Tertiary deposits of the Great Plains region, with an admixture of material derived from shale, sandstone and limestone rocks of the plains. The type is productive and is extensively cultivated to staple farm crops, particularly kafir, sorghum, and cowpeas. Wheat, alfalfa, potatoes, and truck crops are also grown to some extent.

Laurel loam.—The soil is a dark-brown or reddish-brown to dark-gray, rather heavy loam varying considerably in texture. The color usually becomes lighter with depth. Water-worn gravel or sand, frequently interstratified with layers of yellowish-gray or mottled sandy loam and silt loam, is usually encountered at 3 to 6 feet. Underdrainage is sometimes excessive. The type occurs in long, narrow strips covering stream bottoms or lower stream terraces. When well drained and not subject to overflow it is adapted to alfalfa, sugar beets, grains, cantaloupes, sorghums, kafir and other forage crops, potatoes, and the later vegetables.

Lincoln loam.—This type is a dark-brown loam, which becomes nearly black when wet. The subsoil is a brown, compact loam to clay loam, and extends to a depth of 3 feet or more. Small spots of alkali occur at the surface in places where the topography is so level that drainage is obstructed. The type is developed in small stream valleys in the central-western prairie States. The material represents deposits by streams draining areas of unconsolidated or partially cemented Tertiary deposits, derived mainly from crystalline rocks. It differs from the Arkansas loam mainly in the absence of the sandy and gravelly substratum which occurs in that type. The soil produces good yields of corn, wheat, alfalfa, kafir, and some of the heavier types of vegetables, such as cabbage and onions.

Tripp loam.—The type consists of a light-brown, friable loam, underlain by a subsoil of similar texture but somewhat lighter brown or yellowish color. The topography is undulating and the type is well drained. The surface features are well adapted to irrigation. The type occupies valley terraces. It is of alluvial origin and is derived from crystalline shale and sandstone materials, some of which have been transported long distances from the Rocky Mountain region or from areas of the Great Plains region occupied by Tertiary deposits. The material has in places been subsequently modified by the addition of wind-blown material. The type is not retentive of moisture, but under irrigation it is adapted to wheat, oats, alfalfa, potatoes, and vegetables.

Vale loam.—The surface soil consists of 12 to 30 inches of reddish-brown loam. The subsoil is also reddish brown, but heavier than the soil. The type occupies slopes along streams and is generally well drained. It is of alluvial origin, and deposited as stream flood plain material derived from granite, gneiss, and schist, with an admixture of red shale and sandstone material. Part of the type is irrigated and produces good crops of alfalfa and small grains. Fruit does well with favorable climate or where properly irrigated.

Wade loam.—The soil to about 8 inches consists of a light to dark-brown or dark-gray loam which is high in silt content. The subsoil is lighter in color than the soil. The type is of alluvial origin, and is derived from shale and sandstone rocks. It occupies lower stream terraces and is subject to overflow in depressed areas. The topography is either level or gently sloping, and drainage is nearly always adequate for farming purposes. There are occasional accumulations of alkali in the lower flats in the more western areas. This is a very desirable bottom-land soil and is adapted to general farming and stock raising. Wheat, flax, oats, and sugar beets are the principal crops. Some corn and millet are grown for stock feeding. Where underdrainage is good the type is adapted to alfalfa.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Wade loam	Colorado 2; North Dakota 7; South Dakota 3	285,568
Tripp loam	Nebraska 7	87,552
Arkansas loam	Kansas 6, 11	69,696
Laurel loam	Colorado 3	37,760
Vale loam	South Dakota 1	3,520
Lincoln loam	Kansas 6	2,560
Total		486,656

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase of the loam group is not extensively developed in this province.

The soil is less compact, more easily tilled, and less retentive of moisture than the normal loams. The gravel content insures good underdrainage.

Where the climate, topographic position and regional drainage are favorable the gravelly loams are better adapted to most of the fruits than the loams, but are usually less valuable for general farming.

Wade gravelly loam.—The surface soil is a loam less than 18 inches in depth. This is underlain by a loam or light clay loam about 3 feet deep resting upon beds of water-worn gravel. Both soil and subsoil contain gravel. The type occupies terraces which were formerly river banks. It is free from alkali and well drained. The areas occurring on plateaus, where the gravel content is not excessive, the soil is well adapted to grain and alfalfa, apples, and sugar beets.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Wade gravelly loam	Montana 1	11,776

[1] For key to number in this column see p. 733.

SILT-LOAM GROUP.

The silt loams of this province are of common occurrence in the northern, middle, and western parts of the Great Plains region, but are less extensive than the loams or fine sandy loams.

The soils vary widely in topography, drainage, character of underlying material, and regional climate. Lower-lying bodies are sometimes overflowed or poorly drained, but in general the group is free from overflow and fairly well

drained. In the northern part of the region the winters are particularly severe. In the western areas the rainfall is usually inadequate for agriculture without irrigation. In certain sparsely settled districts stock raising constitutes the principal industry. Wheat, oats, barley, corn, alfalfa, and potatoes are the principal crops. Flax is an important crop in the northern areas. In the middle western arid districts, where dry farming is practiced, the more drought-resistant crops, such as millet, sorghum, kafir, etc., are grown. Sugar beets are produced extensively in some of the irrigated districts. Vegetables, small fruits, and tree fruits, consisting of apples, peaches, berries, and grapes, are grown locally to a limited extent.

The soil material is moderately sticky, and in some cases shows a pronounced tendency to puddle and bake if cultivated when wet. Where properly supplied with moisture, drained, and cultivated, the soil is usually friable and retentive of moisture. The silt loams require somewhat more careful management and thorough cultivation in order to maintain good tilth than the soils of the loam group, and demand a heavier farming equipment. They are best adapted to a moderately heavy type of farming, including the production of grain and hay, forage crops, and sugar beets. Stock raising and dairying are important industries. Cantaloupes and late vegetables can be produced commercially where drainage and moisture conditions are favorable. These soils are better than the loams for grass crops and other heavy farm products.

Arkansas silt loam.—The soil is a grayish-brown or brown friable silt loam. This is underlain by a gray or yellowish-brown subsoil. The yellowish gravel and sand substratum, which is typical of this series, does not usually occur within the 6-foot soil section. The topography is generally level or gently sloping, but the surface is sometimes eroded and rendered irregular by overflow waters or by wind action. Surface and subdrainage are usually well established. The type is of alluvial origin and derived from crystalline and sedimentary materials, transported from the Rocky Mountains and from areas of unconsolidated Tertiary deposits of sandstone, limestone, and shale rocks in the Great Plains region. The type occupies river terraces and is subject to overflow only at infrequent intervals. It is adapted to a wide range of crops, including corn, alfalfa, small grains, forage crops, potatoes, tree and small fruits, and vegetables. Corn, alfalfa, and potatoes are the principal products. The type generally supports a growth of timber in the vicinity of stream courses.

Tripp silt loam.—The type consists of a brown to light-gray very silty loam underlain by material similar in texture to the soil but slightly lighter in color. It consists of alluvial material eroded from areas of soils derived from crystalline, shale, and sandstone rocks. It occupies stream bottoms and terraces and the surface is comparatively level. The type is fairly well drained. It is but inextensively utilized, but where moisture conditions are favorable it should produce good yields of the general farm crops adapted to the section in which it is found, including corn, wheat, potatoes, and vegetables.

Wade silt loam.—The soil consists of 6 to 18 inches of gray to nearly black silt loam, containing a high percentage of organic matter. The subsoil is a brownish-yellow loam or sandy loam to silt loam or silty clay. When wet the material becomes plastic. It is an alluvial soil and occupies valley bottoms and terraces. It is derived from shale and sandstone materials. With the exception of small, poorly drained areas and small areas in which alkali occurs, this type is very productive. It produces good crops of wheat, oats, flax, barley, corn, millet, alfalfa, potatoes, sugar beets, and some vegetables.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Tripp silt loam	Nebraska 7; South Dakota 3	142,848
Wade silt loam	Colorado 2; North Dakota 6, 7	32,384
Arkansas silt loam	Kansas 7	17,600
Total		192,832

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loams are widely distributed in the Great Plains region, but are less frequently encountered in the River Flood Plain province than the soils of lighter texture.

They have been recognized under four important soil series, and, like the soils of the preceding group, are subject to wide variation in drainage, character of subsoil or underlying material, temperature, rainfall, and irrigation.

Drainage is much more frequently inadequate than with the other soil groups of the province. The members sometimes occupy depressions which are subject to overflow or to the accumulation of drainage or seepage waters and, in the semiarid districts, of alkali salts. The soil is refractory, becomes sticky when wet, is readily puddled if tilled when in a wet condition, and bakes upon subsequent exposure. It has a high water-holding capacity, and if judiciously managed, frequently cultivated, and properly drained a good tilth may be maintained and the soil made to retain moisture during periods of drought. It requires a heavy farming equipment to be utilized economically and efficiently.

A large part of the area mapped is used for pasture, owing to poor drainage. Where well drained and capable of irrigation or favored by natural moisture supply small grains, alfalfa, sugar beets, and grass crops are produced. Potatoes, garden vegetables, and apples are successfully grown, mainly locally for home use.

The clay loams are not adapted to the commercial production of truck crops and are best suited to a heavy type of general farming with the production of grains, grass, sugar beets, live stock, and dairy products.

Arkansas clay loam.—The type consists of a dark-brown clay loam from 6 to 12 inches deep, underlain by a dark-brown or grayish-brown heavy, compact, and impervious clay. The surface is commonly marked by the presence of alkali incrustations and is often bare of vegetation. The type is of alluvial origin, and derived from crystalline rock material of the Rocky Mountain region or of unconsolidated Tertiary deposits of the Great Plains, modified by material from sandstone, shale, and limestone rocks. It occupies stream bottoms and terraces. Drainage is rather poor, and on account of the heavy alkali content the soil has little agricultural value unless reclaimed by proper drainage.

Lincoln clay loam.—The soil is a dark-brown clay loam about 12 inches deep and is underlain by a dark-brown or grayish, compact, and impervious heavy clay. Where surface drainage is obstructed, alkali incrustations are frequently noticeable, and the soil is barren. The type is developed in the valleys of some of the principal tributaries of the rivers of western prairie States, where it has been deposited as sediments from streams in periods of flood. The material is derived mainly from areas of unconsolidated or cemented Tertiary deposits, coming originally from granitic rocks. Some material from sedimentary rocks is included. On account of the heavy, impervious characteristics of the soil and its tendency to become affected with alkali, the type usually has little agricultural value.

Wade clay loam.—The soil is a dark-gray to black clay loam, with a subsoil which is slightly lighter in color and which varies in texture from a clay loam to clay. Both soil and subsoil are usually tenacious and compact. The deeper subsoil, occurring at depths of 2 to 6 feet, is somewhat variable, and ranges from a sandy loam to sand or sand and gravel. The type is of alluvial origin and occupies stream bottoms and terraces. The topography is generally level or gently sloping. Remnants of abandoned stream channels and gullies and local poorly drained depressions or marshy areas are of occasional occurrence. The water table lies near the surface in the vicinity of some of the lower depressions, but surface drainage and subdrainage are usually well established. The soil is derived mainly from shales and sandstones, but in places it includes an admixture of material derived from both quartz-bearing and quartz-free igneous or metamorphic rocks. The type generally lies well above the present stream channels and is not often subject to overflow. The soil is refractory and requires thorough cultivation and careful management in order to maintain good tilth. Where properly cultivated, drained, and irrigated or supplied by adequate rainfall it is productive and adapted to general farming. Sugar beets, alfalfa, wheat, oats, and other grain and hay crops do well. Potatoes, garden vegetables, and apples are grown to a limited extent.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Wade clay loam	Colorado 2; Montana 1	26,944
Arkansas clay loam	Kansas 6	11,072
Lincoln clay loam	....do	1,536
Total		39,552

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The soils of the clay group of this province are not extensively developed. They have been recognized in the northern and middle sections of the Great Plains region.

They generally occupy low-lying positions and are ordinarily subject to overflow or to the accumulation of drainage and seepage waters, and, in the western areas, to injurious amounts of alkali salts. The soils are intractable and are tenacious when wet, readily puddled, and bake upon exposure during dry periods. Artificial drainage is usually necessary and judicious management and thorough tillage are required. Favorable tilth is maintained with difficulty under average field conditions. A heavy farming equipment is needed in the profitable utilization of the soils for cultivated crops. They are restricted to narrow limits in crop adaptation, and are best suited to grass and forage crops. Over a large part of the areas covered drainage operations are not justified by present land values, and the best use of the soils is for pasture.

The clays should be selected only for the heaviest type of general farming in connection with dairying and stock raising. In this province they are inferior in agricultural importance and in adaptation to crops to the clay loams.

Arkansas clay.—The type is a dark-gray or dark-brown to almost black, heavy, tenacious clay, underlain at depths of 8 to 12 inches by a darker gray or drab, tenacious clay which is frequently mottled with lighter gray. At about 3 feet interstratified sand and gravel is usually encountered. The soil is very heavy if plowed under unfavorable moisture conditions. The type occupies stream bottoms and terraces. The topography is almost level and the type sometimes occupies even basin-shaped depressions. Surface drainage is deficient, and unless the underlying gravel lies within 2 feet of the surface water is likely to stand for long periods. Underdrainage, however, may in many places be effected by boring into the porous substratum. The type is of alluvial origin. It is formed of materials from crystalline rocks of the Rocky Mountains or from areas of unconsolidated Tertiary deposits of the Great Plains region, with an admixture of material from sedimentary rocks. Some areas of this type are influenced by the presence of alkali salts in amounts injurious to the growth of plants. Where well drained and properly cultivated, the greater part of the type is adapted to the production of grasses, sorghum, kafir, and grains.

Wade clay.—The type consists of a clay, varying in color from gray to black, resting upon a subsoil of heavy clay, somewhat lighter in color than the soil and sometimes underlain by a deeper subsoil of sand and silt. The soil is compact, and bakes and cracks badly upon exposure during dry periods. The material is alluvial and is derived from the erosion of shales and sandstones. The type occupies stream valley bottoms and terraces. The surface is nearly flat and drainage is poor. The type is frequently subject to injurious accumulations of alkali salts. It is largely devoted to pasture, though it is a productive soil and would produce grass crops and forage plants if properly drained and cultivated.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Wade clay	Colorado 3; Montana 1; North Dakota 6, 7	29,440
Arkansas clay	Kansas 6	1,152
Total		30,592

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

The silty clay soils of the River Flood Plains province in the Great Plains region are represented by only a single member, which is of comparatively inextensive occurrence.

Both surface and subdrainage are poor, and the soil is utilized mainly for the production of hay. It is not well adapted to other crops without artificial drainage.

The type constitutes an unimportant phase of the clay group, from which it does not depart widely in agricultural importance or crop adaptation. Under prevailing conditions of drainage the soil is somewhat more easily worked than the normal clays of the province, and is slightly better adapted to farming. It is suited only to a heavy type of general farming or to dairying and stock raising, and requires heavy farming equipment.

Bassett silty clay.—The soil is dark gray to brown, and ranges in depth from 6 to 12 inches. The upper subsoil is gray or lighter brown in color and heavier and more compact than the soil. The deeper subsoil is a heavy, compact clay of light ashen gray or white color, and usually occurs at a depth of 3 to 5 feet. The type occupies level or somewhat depressed areas of stream valley flood plains and terraces. Surface drainage is poor, and percolation and subdrainage are retarded by the heavy subsoil. The type is of alluvial origin and derived from crystalline sandstone and shale, and probably includes some material from calcareous rocks. It is devoted mainly to the production of wild hay, to which it is best adapted.

Area and distribution of the silty clay.

Soil name.	State or area.[1]	Acres.
Bassett silty clay	Nebraska 7	64,512

[1] For key to number in this column see p. 733.

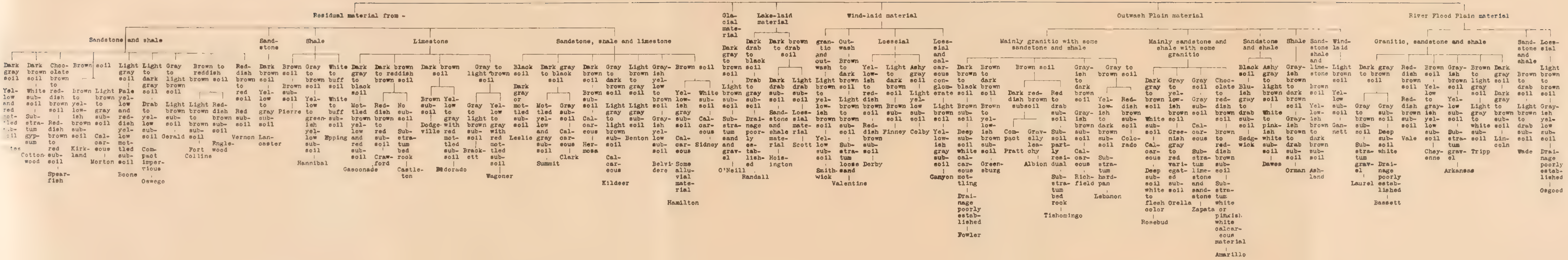
MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Dunesand	Colorado 3; Kansas 6, 10; Nebraska 7; South Dakota 3	13,045,952
Rough broken land	Nebraska 7; Texas 22	3,262,464
Rough stony land	Kansas 1, 7, 11; Missouri 2, 3; Oklahoma 1, 2; South Dakota 3; Texas 2, 11, 28; Wisconsin 5, 7.	3,046,643
Bad lands	North Dakota 10; South Dakota 3	2,896,128
Alluvial soils undifferentiated.	Kansas 6; Nebraska 7; North Dakota 10; South Dakota 3; Texas 22.	2,679,424
Bad lands basins	South Dakota 3	292,608
Riverwash	Colorado 3; Nebraska 7	128,000
Sands and Peat	Wisconsin 7	101,696
Peat and Muck	Wisconsin 7	39,616
Rock outcrop	Kansas 1, 4; Texas 2, 26, 31	31,654
Swamp	Colorado 3	640
Total		25,524,825

[1] For key to numbers in this column see p. 733.

Key to the Soils of the Great Plains Region.



SOILS OF THE ROCKY MOUNTAIN AND PLATEAU REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

The Rocky Mountain and Plateau region as recognized by the soil survey covers the areas of elevated mountains and plateaus extending from the Dominion of Canada upon the north southward to the lower lying, arid, treeless plains and isolated ranges of the Southwestern Arid region in New Mexico and Arizona, and from the Great Plains upon the east to the less elevated desert plains, valleys, and ranges of the Northwestern Intermountain and the Great Basin regions upon the west. In the extreme northern part its western boundary is for a short distance formed by the eastern boundary of the Pacific Coast region where the two merge in the Okanogan Highlands in north-central Washington. Upon the east and north in the extreme northern portion it touches the plains and prairies of the Glacial and Loessial province. The Black Hills uplift and several other outlying ranges of the Rocky Mountain system, some of which in the southern part of the region extend across south-central New Mexico and into western Texas, are also included.

As thus defined, the region embraces western Montana, northern and central Idaho, the northeastern part of Washington, the western half of Wyoming and Colorado, more than half of Utah and Arizona, and about one-half of New Mexico, in addition to small areas in eastern Wyoming and in South Dakota and Texas.

The region falls into two distinct and characteristic physiographic provinces, consisting of the Cordilleran, or mountain portion, extending with a general northwesterly and southeasterly trend across the entire area covered by the region and including isolated outliers; and of the Plateau districts of the central and southwestern sections of the region.

The Cordilleran portion of the region, with its outliers, includes the elevated and rugged ranges, ridges, and domes of the Rocky Mountain system, with inclosed intermountain valleys and parks. In Montana and Idaho it embraces the districts covered by the main range of the Rocky Mountains, constituting the Continental Divide, and by the Little Belt, Big Belt, Bridger, Gallatin, White Fish, Mission, Cabinet, Bitter Root, Salmon River, Coeur d'Alene, and detached minor ranges. In Wyoming it includes the elevated plateaus, ranges, and peaks of the Yellowstone Park and adjacent districts, and the Shoshone, Wind River, Green, Big Horn, and Laramie ranges and the outlying uplifts of the Black Hills extending into South Dakota. It embraces in northwestern and north-central Utah, with the adjacent portion of Idaho, the Wasatch and Uinta ranges, and in Colorado and north-central New Mexico the Medicine Bow, Park, Front, Seguache, San Juan, Sangre de Cristo, Culebra, and less elevated and extensive ranges, with the included basins and valleys.

Upon the south the principal outlying areas include the elevated regions covered by the San Francisco Mountains and the Mogollon and Black Mesa regions in Arizona, and by the Sacramento and Guadalupe ranges in New Mexico and Texas. Upon the west of the main Cordilleran Belt, in Colorado and Utah several less extensive but prominent outlying masses occur, including the Henry Mountains in Utah, Grand Mesa in Colorado, and others.

The region embraced within this mountain portion of the Rocky Mountain and Plateau region ranges from within the vicinity of 3,000 to more than 14,000 feet in elevation, the less elevated sections occurring in northeastern Washington, southeastern Arizona, southern New Mexico, and western Texas. Much of the area covered lies at an altitude of more than 8,000 feet, and, with the exception of the included structural basins and the comparatively flat tops of some of the elevated mesas or plateaulike masses, is usually rugged.

A variety of rocks are represented, the most of which have been crushed, folded, and faulted.

In Montana and Idaho they include granites and other quartz-bearing, as well as quartz-free, intrusive and effusive rocks, limestones, and other rocks of sedimentary origin, and various metamorphic rocks. In Washington they consist mainly of metamorphic rocks of igneous and sedimentary origin and of undetermined age. In the Yellowstone Park region of Wyoming the rocks are mainly of effusive origin, while in the more central and southern parts and in the Black Hills districts areas of Carboniferous, Cretaceous, Jurassic, and later sedimentary and metamorphic and of the ancient gneisses or granitic rocks are more extensively developed. In the Wasatch and Uinta ranges the rocks are prevailingly of sedimentary and metamorphic character, with some areas of volcanic origin. In Colorado, New Mexico, and Arizona widespread exposures of volcanic rocks and of ancient granites and less extensive areas of stratified rocks of Carboniferous and later ages occur.

Extensive areas of the higher and more northern ranges of the region have been subject to modification of superficial features by glaciers, a few remnants of which still remain.

The lower and more southern regions are of arid or semiarid character and but sparsely timbered, while the central and more northern or more elevated districts are subject to heavy precipitation, occurring largely as snowfall, and are heavily forested.

Springs and perennial streams are abundant over much of the mountain portion of the region, and the more elevated and more northern parts are sufficiently well supplied with moisture to produce crops without irrigation.

However, on account of the altitude, severity of climatic conditions, rough, rocky character, and the frequently inaccessible locations, the mountain areas are inextensively cultivated, and where utilized are devoted mainly to grazing. The irrigable soils are practically confined to the intermountain valleys and topographic basins, some of which occupy protected or favored locations, and have attained a high state of development. Among these inclosed valleys of the province are included the San Luis Valley in south-central Colorado and north-central New Mexico, the Gallatin, Madison, and Jefferson Valleys in south-central Montana, and the Bitter Root Valley in western Montana.

The plateau portion of the region covers the elevated, desert-like, flat to sloping plains of southwestern Wyoming, western Colorado, the southeastern half of Utah, northern Arizona, and northwestern New Mexico, the most of which ranges from 5,000 to 7,000 feet in altitude. It is characterized by gently tilted or horizontal rocks, in places of Carboniferous but generally of "Juratrias" or Cretaceous age, sandstones and shales predominating, occupying an uplifted elevated position and usually marked by frequent fault scarps, which also generally separate the plateaus from adjacent lower lying regions. It is traversed by infrequent perennial streams, often flowing through deep, gorge-like canyons, but is frequently deeply dissected and gullied by tributary streams of intermittent character. In the areas of softer rocks, wide valleys have been eroded along stream courses.

The northern portions of the plateau province occurring in the Green River and Wind River Basins in Wyoming are partially separated from the more typically developed and more extensive areas upon the south by the Uinta Mountains, while upon the west the plateau portion of the region extends to the Great Basin region of interior drainage. Its southern boundary is less definite and is formed by the deserts and mountains of the Southwest Arid region in Arizona and New Mexico. Upon the east it extends to the higher rugged ranges of the Rocky Mountains of Colorado and New Mexico and to the valley of the Rio Grande. Within this great extent of territory occur occasional volcanic mountain masses or uplifts of the older sedimentary or altered rocks referred to the mountain province of the region.

Only the more elevated mountain ridges and plateaus included within the area of the plateau province support timber or forest growth, which usually consists of stunted cedars or pines, but occasionally small areas of timber of economic importance are encountered. The plains are dominated by arid or semiarid conditions of climate, accompanied by long-continued periods of sunshine and by excessive and rapid radiation. The summers are usually warm or hot, and, considering the altitude, are accompanied by a long growing season. The winters are mild and conducive to the ranging of stock. The soils are productive under irrigation and adapted to a wide range of crops. They are not generally adapted to the production of dry-farmed crops, and many of the streams, owing to inconstant flow or topographic position, are unsuited as a source of supply for

irrigation, and much of the region is relatively inaccessible to markets and unutilized for agriculture or devoted only to a grazing industry.

The soils of the Rocky Mountain and plateau region vary widely in character, owing to wide latitude in character of material from which they are derived and in the agencies active in their formation. They are further subject to wide variation in topography and in conditions of environment as related to climatic influences, dry farming, irrigation, and market and transportation facilities. The natural agencies dominant in their formation have given rise to several distinct provinces of soil material. Owing to the fact that only a few of the more densely settled and more highly developed agricultural districts of the region have as yet been covered by the soil survey, only a comparatively small number of soil series representing the various provinces of soil material have been recognized.

Weathering of the consolidated rocks in place has given rise to extensive areas of residual soils. Upon the mountain slopes much of the weathered material finds its way, mainly by gravity, to the lower slopes, constituting areas of colluvial soils. The soils of the mountain areas of the region are prevailingly of residual and colluvial origin. In the plateau districts also, where not removed or superficially covered with other material by transporting agencies, the soils are predominantly of residual character. Little of the strictly colluvial soils of the region has as yet been encountered, but those of the residual province have been encountered to some extent in parts of the areas surveyed.

About the base of the mountains, mesas, plateau escarpments, and bluffs and cliffs of the river valleys occur extensive accumulations of alluvial material deposited by streams debouching from the adjacent valley barriers or washed from the adjacent slopes. These streams traverse areas of high gradient and are usually of intermittent, shifting character, and during periods of flood deposit their load of débris below the point at which they emerge from their canyon mouths or ravine or gully courses, building up deposits of stream outwash as alluvial fans and detrital-filled valley plains. The soils derived from these deposits are included under the soil province designated as the soils of the alluvial fan and valley filling material.

In some of the intermountain basins or valleys extensive deposits of sediments laid down in the waters of former lakes have been accumulated, giving rise to the soils of the lacustrine or lake-laid province which are represented by the Manhattan series.

Along the flood plains and terraces of the stream valleys several series of alluvial soils of variable character have been accumulated, representing material transported and deposited by the waters of the streams, or, in the case of the coarser material, pushed and rolled along the stream channel. This class of material has given rise to the soils of the river flood plain province.

While the soils of the more northern intermountain basins and valleys are devoted mainly to an extensive system of farming, conditions are usually favorable to the development of a more intensive and profitable system of agriculture. In the mountain districts local areas of valley lands and of the more gentle slopes now unutilized will eventually be devoted to agricultural purposes. In the southern plateau districts and valleys of the central and southern portions of the region the extension of agriculture is in the main contingent upon the further development of irrigation facilities. That prevailing climatic and soil conditions are favorable to agriculture under irrigation is evidenced in a striking manner by the high degree of success attained in some of the irrigated areas devoted to general farming and to intensively cultivated fruit and other special products, often under unusual conditions of altitude, which in some of the important agricultural districts ranges from 5,000 to more than 7,000 feet.

The following areas of the different soil provinces of the Rocky Mountain region have been surveyed:

Soil province.	Acres.
Residual material	132,736
Alluvial fan and valley filling material	420,992
Lake-laid material	53,824
River flood plain material	512,192
Miscellaneous material	42,176
Total for region	1,161,920

RESIDUAL MATERIAL.

The residual soils are of extensive occurrence in the Rocky Mountain region. Those derived from sedimentary deposits are, however, more favorably situated with regard to climate, irrigation facilities, transportation, and markets, and have been much more extensively developed to agriculture. Since the areas covered by the soil surveys have been confined mainly to the longer settled and more extensively developed agricultural districts, the soils of the residual province have not been surveyed to an extent comparable with their regional distribution.

The residual soils of the mountainous portions of the region are mainly of too rough topography to be adapted to agriculture. They are usually of a thin, rocky character, and in the more elevated or more northern districts are subject to severe climatic conditions. They are derived from a variety of rocks. None of the residual soils of the mountainous portions of the region have as yet been mapped. Those of the plateau portions of the region, where uneroded, are of comparatively level or gently sloping or undulating surface, favorable to the distribution of irrigation waters. Extensive areas of dissected or eroded surface occur, however, which are totally unadapted to irrigation or in which the distribution of irrigation waters is dependent upon the construction of costly engineering works and upon expensive leveling in preparing the land for irrigation practice. Water supply for irrigation purposes is here limited.

Transportation facilities are inadequate, and the greater portion of the residual soils of the plateau plains are of value only for grazing. The soil areas more favorably situated with regard to climatic conditions are capable of producing drought-resistant crops without irrigation, but such areas are infrequent and of limited extent. The soils support a scanty growth of native vegetation suitable for grazing purposes. Certain irrigated areas bordering stream valleys are devoted to the production of general farm crops; and fruits, truck products, and other intensively cultivated crops are grown under favorable local circumstances.

The residual soils of the plateau plains are derived mainly from shales and sandstones, often of calcareous character. They are thin, and those derived from shales are impregnated with alkali salts. Surface drainage is usually well established, but subdrainage is imperfect, and the soils of the slopes are marked by the occurrence of seepage zones or alkaline springs.

In so far as encountered, the soils are recognized under the Albany, Bent, Chipeta, and Shavano series. None of these have been recognized under conditions of wide distribution or extensive agricultural development. The more important soils occur under the Chipeta series.

DESCRIPTION OF THE SOIL SERIES.

Albany series.—The soils of the Albany series are of red color. The subsoils usually resemble the soil material in color, texture, and structure, and are frequently underlain at a depth of less than 6 feet by a bedrock stratum which contains large amounts of gypsum and other alkali salts. The members of the series occupy sloping to rolling or dissected, treeless plains. The soils are of residual origin and are derived from soft red sandstone and shales of the Permian and Triassic Red Beds formation. They carry excessive amounts of alkali salts and are well drained. They are not favorably situated for irrigation and are utilized mainly for grazing.

Area and distribution of the soil of the Albany series.

Soil name.	State or area.[1]	Acres.
Albany fine sandy loam	Wyoming 1	42,624

[1] For key to number in this column see p. 733.

Bent series.—The soils of the Bent series are light brown or yellowish brown. The subsoils are of a somewhat lighter brown tint than the surface material and generally of compact structure. Crystals of gypsum and other mineral

salts are present, particularly in the subsoil. The members of the series occupy treeless plains of flat, depressed, and gently sloping, rolling, or eroded and broken character. The soils are of residual origin and derived mainly from shales, in many places calcareous. Small granitic fragments and water-worn pebbles derived from adjacent Tertiary or early alluvial deposits sometimes occur. The higher-lying bodies are well drained, but the more numerous lower slopes, depressions, and lakelike basins are subject to accumulation of surface or subsurface waters. The soils are retentive of moisture and, when favorably situated with respect to climate, topography, and irrigation facilities, are capable of producing general farm crops. They are utilized mainly for grazing.

Area and distribution of the soil of the Bent series.

Soil name.	State or area.[1]	Acres.
Bent clay	Wyoming 1	16,064

[1] For key to number in this column see p. 733.

Chipeta series.—The soils are of light to dark-gray or grayish-brown color, and are underlain by soft weathered shales at shallow depths. Both soil and subsoil are marked by the occurrence of flat fragments and angular chips of shale rock. The subsoils are compact and impervious. The Chipeta soils are of residual origin, derived from gray to dark-brown or black Cretaceous shales. These shales are usually of fissile character and carry local thin beds of limestone and sometimes sandstone, accompanied by thin coal seams. The joints and checks contain gypsum, calcite, and saline deposits, the latter forming a prominent source of the alkali salts which occur in the members of the series. The soils occupy gentle to precipitous slopes of scanty vegetation, are eroded into bad-land forms of topography, and are marked by outlying buttes and hills isolated from the plateau or mesa surfaces by erosion. Although the surface is sloping, the members of the series are subject to seepage, local conditions of poor drainage, and the accumulation of alkali salts. The soils are of a refractory, tenacious character when wet, are readily puddled, and often bake upon subsequent exposure. The series is not adapted to dry farming or to fruit culture, but under favorable conditions of irrigation, cultivation, and drainage is suited to grains, and the deeper phases to alfalfa.

Area and distribution of the soils of the Chipeta series.

Soil name.	State or area.[1]	Acres.
Chipeta clay loam	Colorado 5	960
clay	Colorado 1, 5	64,128
Total		65,088

[1] For key to numbers in this column see p. 733.

Shavano series.—The soils are of pinkish-red or reddish-gray color, of shallow character, and are marked by outcrops of the underlying parent rock. Small amounts of residuary water-worn gravel, representing remnants of eroded Neocene deposits or old-stream terrace deposits, are present, giving rise to the soils of the Mesa series. They cover elevated, sloping to hilly, and dissected areas of plateau and mesa lands. The soils are derived from the weathering in place of a reddish or reddish-gray Cretaceous sandstone of fine texture. They are of low water-holding capacity. The soils are treeless and undeveloped, except under favorable conditions of irrigation and location, where the deeper bodies are adapted to fruits and general farm crops.

Area and distribution of the soil of the Shavano series.

Soil name.	State or area.[1]	Acres.
Shavano fine sandy loam	Colorado 5	8,960

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Three of the four series recognized under the province of residual soils in the Rocky Mountain region are represented only by single soil types. Under the other series two types have been encountered.

The lighter textured soils of the province are derived predominately from fine-grained sandstones and include only types of fine sandy loam texture occurring under the Albany and the Shavano series. The soils of the sand, fine sand, and sandy loam groups have not as yet been encountered in this province. The soils of heavy texture are derived from shales and are represented by the clay loam and clay types occurring under the Bent and the Chipeta series.

The soils of the Albany, Bent, and Shavano series, where mapped, are confined to single areas surveyed. Those of the Chipeta series are represented in both the Grand Junction and the Uncompahgre area, Colorado. Some of the areas covered by these soils, particularly those of the Albany and Bent series, embrace undifferentiated types of soils which would in more detailed surveys be recognized as material of other soil series and provinces.

The fine sandy loams are of shallow depth and cover areas of eroded, rough topography. The general surface is gently sloping and favorable to irrigation and the use of farm machinery. Most of the areas lie above sources of water supply for irrigation and the soils are inextensively utilized except for grazing purposes. Drainage is well established. The soil is distinctly loamy when moist and is friable and easily maintained in a good condition of tilth under cultivation. Where capable of irrigation, the areas of deeper soil and favorable topography can be utilized for the culture of vegetables, peaches, cherries, and other stone and small fruits, while the shallow areas are best suited to grains or other shallow-rooted crops.

The fine sandy loam of the Albany series is the most extensively developed of the two members representing the soils of the fine sandy loam group, both of which are, however, of but little agricultural importance.

The soils of the clay loam group are represented only by the clay loam member of the Chipeta series. The topography is undulating to moderately rolling, but the surface is sometimes badly gullied and irregular. The soil is of sufficient depth to permit root development of all but the deeper-rooted crops. Surface drainage is well established, but subdrainage is retarded by the compact and impervious nature of the soil and subsoil and the underlying shales. The subsoils contain injurious amounts of alkali salts which accumulate in local areas of poor drainage or along slopes where underground seepage waters reach the surface. The soil is of tenacious, refractory character, is deficient in organic matter, and is readily puddled and rendered intractable under injudicious methods of management. It demands a heavy farming equipment and thorough and careful cultivation. It is not suited to the commercial culture of fruit or vegetables, but under favorable conditions of irrigation, drainage, and culture is adapted to heavy general farming purposes. In the better-drained localities of good depth the clay loams are also well suited to alfalfa, and where sufficiently friable to potatoes. Alfalfa, oats, wheat, and potatoes are the principal products.

The soils of the clay group, under the Bent and the Chipeta series, are of more compact, refractory structure than the clay loam. They are poorly drained and subject to the occurrence of seepage waters and alkali salts. The topography varies widely. Some of the areas included are rough or eroded, the surface drainage being excessively developed. Subdrainage is, however, restricted and seepage waters and alkali salts appear along slopes. The lower-lying areas vary from gently sloping to flat, and are poorly drained and subject to an extensive accumulation of alkali salts.

The clays require a heavy farming equipment and careful management. They are maintained in a favorable condition of tilth with greater difficulty

than the clay loam of the province and are more limited in adaptability to crops. The lower lying, poorly drained areas can be improved by artificial drainage. Where so improved or where natural drainage conditions are favorable, if carefully and thoroughly tilled and capable of irrigation the soils are fairly well adapted to heavy farming purposes. The clay of the Bent series is utilized mainly for grazing. That of the Chipeta series occurs under somewhat more favorable conditions of drainage, but is not extensively used. Where capable of irrigation, however, it can by judicious management be utilized for the culture of grains, alfalfa, and probably sugar beets, though it is not as well suited to the latter as the soils of more friable structure.

Fine Sandy Loam Group.

Albany fine sandy loam.—The soil is of red color and friable structure. The subsoil is quite similar in color, texture, and structure to the soil material. It is underlain at a depth of less than 6 feet by a substratum of sandstone and shale. The soil and subsoil contain limestone fragments, and in places material derived from limestone rocks. The type occurs as well drained, sloping to eroded, treeless plains, usually not suited to irrigation. It is not extensively utilized for any agricultural purpose except grazing.

Shavano fine sandy loam.—The Shavano fine sandy loam to a depth of 15 inches to 4 feet is of reddish-gray color and rather heavy texture. It is underlain by a reddish-gray sandstone of fine texture, from which the type is derived. A small amount of gravel occurs, due to an admixture of remnants of Eocene or old stream terrace deposits which have been removed by erosion. The soil is rather sticky when wet and resembles a loam in general appearance. It is usually free from alkali and well drained, but is dissected by gulches and ravines traversed by intermittent streams. It occupies elevated positions on sloping mesas or plateaus and supports a scant growth of native vegetation. The soil is shallow and possesses a low water-holding capacity. It is rather deficient in organic matter and is not adapted to deep-rooted crops. Under irrigation, however, the deeper areas are suitable for the production of peaches, cherries, small fruits, and grains.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Albany fine sandy loam	Wyoming 1	42,624
Shavano fine sandy loam	Colorado 5	8,960
Total		51,584

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

Chipeta clay loam.—This is a light grayish-brown soil, extending to a depth of from 24 inches to 6 feet, underlain by a grayish-brown shale of undetermined depth. Its generally uniform texture varies somewhat with the character of the underlying parent shale. The type occupies gently undulating to moderately rolling areas. It is marked by accumulations of small shale rock fragments of coarse granular appearance, which break down into soil upon application of water in considerable quantities. The soil is gullied by intermittent streams or heavy rains, and, owing to its compact structure and heavy character, considerable care must be exercised in cultural operations in order to prevent puddling and insure good tilth. It is locally subject to injurious accumulations of alkali salts or to seepage, and is rather deficient in organic matter content. When properly managed it is adapted to alfalfa, grains, and potatoes.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Chipeta clay loam	Colorado 5	960

[1] For key to number in this column see p. 733.

CLAY GROUP.

Bent clay.—The soil is of yellowish or yellowish-brown to brown color and of heavy, compact character. It becomes sticky when wet, puddles readily, and upon subsequent exposure bakes and becomes impervious to water. The subsoil is of similar color, texture, and structure, and contains gypsum and lime. A bedrock substratum occurs in the shallower areas at a depth of less than 6 feet. The type occupies lower slopes and depressions, but some abrupt slopes with outcropping ledges of parent rock occur. It is of residual origin and derived mainly from calcareous shales. The soil is poorly drained and of refractory character under irrigation. It contains injurious amounts of alkali salts, and, owing to the expense and difficulty of drainage, is utilized mainly for grazing.

Chipeta clay.—The soil is a light to dark-gray or slaty-brown clay, from 18 to 48 inches in depth, sometimes underlain by a silty clay subsoil, overlying shale. The color and texture of the soil and subsoil vary with the character of the parent material. The soil is subject to erosion and puddles readily if cultivated while too wet or otherwise improperly handled. It occurs in extensive areas of gently undulating or rough, rolling, dissected topography. It is well drained, except in low-lying depressions or where subject to seepage from shale hills or more elevated soils. In these local areas injurious amounts of alkali salts and excess seepage waters may occur. Much of the type is of too uneven and irregular surface character to be well adapted to irrigation. The soil is treeless, supporting only a growth of desert shrubs. It is not well suited to fruit culture, but the more level areas suitable for irrigation are adapted to grains, sugar beets, and alfalfa, although not utilized to any extent at present.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Chipeta clay	Colorado 1, 5	64,128
Bent clay	Wyoming 1	16,064
Total		80,192

[1] For key to numbers in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The soils derived from the alluvial fan and valley filling material are of widespread occurrence in the Rocky Mountain region. They are represented in nearly all the areas covered by the soil survey and form a large portion of the total area of soils mapped in the region.

They occupy areas of gentle to rather pronounced slope. The surface is locally gullied or eroded or wind blown, and in the immediate vicinity of talus or colluvial mountain slopes is of stony or rocky character, but the general contour is favorable to the economical use of farming implements and to the practice of irrigation. The higher lying and more extensive areas are well drained, but some of the lower lying soil bodies are subject to the accumulation of seepage waters and, in the more arid districts, to injurious concentrations of alkali salts. Water supply for irrigation is limited, and extensive areas of the soils occurring under the province lie above the gravity-distributed irrigation systems. In certain of the areas, however, there are attractive possibilities of extending irrigation by means of storage, while in the more northern areas, and to a limited extent in those of more restricted rainfall, the production of grains without irrigation is successfully accomplished. Irrigation is, however, essential to an intensive and highly developed system of agriculture. The conditions of transportation and markets and local climatic influences vary widely and closely limit and determine the present utilization of the soils of the province.

The soils of this province have been recognized under five series, the more extensive and typical of which are the Bridger, Fruita, and San Luis series. While the members of some of the series occur extensively in areas in which they have been mapped, each of the series recognized under this soil province has been recognized only in a single locality or area surveyed.

DESCRIPTION OF THE SOIL SERIES.

Alamosa series.—The soils are dark brown to black. They usually contain a considerable amount of organic matter and carry water-worn pebbles or gravel. The subsoils are gray to brown, of a gravelly, porous character, and are underlain by a porous stratum of water-worn gravels and sands. The series is of alluvial origin, derived mainly from volcanic rocks, and occupies bottoms and lower stream terraces.

The surface is smooth and suited to irrigation. Drainage is deficient, and the soils are subject to surface accumulations of alkali salts. The poorly drained areas are devoted to native hay or to grazing. Under favorable conditions of drainage, irrigation, and climate, the soils are adapted to alfalfa, Canada field peas, grains, forage crops, and hardy small fruits and vegetables.

Area and distribution of the soils of the Alamosa series.

Soil name.	State or area.[1]	Acres.
Alamosa sandy loam	Colorado 4	35,776
clay loam	do	23,104
Total		58,880

[1] For key to number in this column see p. 733.

Bridger series.—The soils are dark brown to black, and are underlain by sticky, compact, and often calcareous subsoils of light-gray or yellow color. The soils and subsoils contain gravel, which varies from fine, angular chips to large, well-rounded, or angular blocks and cobbles. The type occurs upon mountain and lower foothill slopes, high or sloping plains, mesa lands, and alluvial fans. It occupies small, irregular to broad, extensive areas. The soils consist of alluvial fan and alluvial slope deposits, distributed by streams or by surface wash. The higher lying areas are marked by rock outcrop or bowlders and are deeply cut by stream channels. The soils are treeless or sparsely timbered, except in the vicinity of streams. The members of the series are derived from granitic rocks, gneiss, or basalt, andesite, or other volcanic rocks, with an admixture of materials derived from sedimentary rocks. The soils are well drained, retentive of moisture, and extensively utilized for the production of dry-farmed grains, including wheat, oats, and barley, although irrigation is sometimes necessary for producing these crops. Under irrigation alfalfa, clover, and timothy are also produced to a limited extent.

Area and distribution of the soils of the Bridger series.

Soil name.	State or area.[1]	Acres.
Bridger gravelly loam	Montana 2	12,544
clay loam	do	1,472
Total		14,016

[1] For key to number in this column see p. 733.

Cedaredge series.—The soils are dark or black and carry much organic matter. The subsoils are of mottled gray, yellow or drab color, and are underlain by gravel at less than 6 feet in depth. The type consists of recent alluvial fan or alluvial foot-slope deposits, with some colluvial material derived mainly from more elevated soils, mainly of the Mesa series, and deposited in depressions of local stream valleys under conditions of restricted drainage. The soils are poorly drained, but with favorable irrigation and drainage facilities are adapted to truck, small fruits, and general farm crops.

Area and distribution of the soil of the Cedaredge series.

Soil name.	State or area.[1]	Acres.
Cedaredge clay loam	Colorado 5	576

[1] For key to number in this column see p. 733.

Fruita series.—The soils are light reddish gray or grayish brown with a reddish tint. The subsoils are generally similar to the surface material, but are sometimes of darker color, and include stratified loams, fine sandy loams, and sands. Both soil and subsoil are of somewhat compact structure, but are friable under cultivation. The series occupies alluvial fan and stream terrace slopes, lying at an average elevation of 10 feet above alluvial flood plains. Drainage is deficient along lower slopes and the soils are subject to the accumulation of alkali salts and seepage waters from irrigation. The soils are adapted to the production of fruits and sugar beets. Apples and pears are profitably grown upon the better drained areas, but the soils are principally utilized for the production of alfalfa, grains, sugar beets, and vegetables.

Area and distribution of the soils of the Fruita series.

Soil name.	State or area.[1]	Acres.
Fruita fine sandy loam	Colorado 1	3,968
loam	do	512
Total		4,480

[1] For key to number in this column see p. 733.

San Luis series.—The soils are of reddish-brown color and porous structure, and are underlain by sands and coarse rounded gravel. They occupy filled valleys, as broad, nearly level or gently sloping arid plains, the surface being broken only by small mounds or ridges generally produced by wind drifting. The series occurs over small, irregular to broad, extensive areas. The soils consist of water-laid material transported by intermittent, torrential mountain and foothill streams, deposited as alluvial fan or detrital cone material, containing medium to fine gravel. They are derived mainly from volcanic rocks, principally andesites, rhyolites, and trachytes. The lower lying areas are subject to injury by the accumulation of seepage waters and alkali salts from irrigation upon more elevated slopes.

Area and distribution of the soils of the San Luis series.

Soil name.	State or area.[1]	Acres.
San Luis sand	Colorado 4	136,960
sandy loam	do	196,992
loam	do	9,088
Total		343,040

[1] For key to number in this column see p 733.

THE SOIL TYPES AND THEIR USE.

The soils derived from the Alluvial Fan and Valley Filling Material as recognized include a number of types, ranging in texture from sand to clay loam. Under each of the soil series, however, only a comparatively few types have as yet been encountered.

The soils of the Bridger series are confined to the Gallatin Valley in Montana, while those of the Alamosa and San Luis series occur only in the San Luis Valley in Colorado. In both these localities the climatic conditions are rather

severe, the soils occurring at a high altitude and being subject to a short growing season. Grain, hay, and forage crops are the principal products. Conditions are usually prohibitive of successful fruit culture, and only the hardier of the small fruits and vegetables are grown. The soils of the Fruita and the Cedaredge series in the Grand Junction and Uncompahgre areas, Colorado, occur under much more favorable conditions of climate and are adapted not only to general farming purposes but to intensively cultivated special products. The soils of the Fruita series contribute extensively to the production of fruit, sugar beets, and vegetables in the Grand Valley, which constitutes one of the most intensively cultivated and highly developed agricultural districts of the Western States. The Cedaredge series is represented by a single soil type of local occurrence. It is not extensively utilized, but with improvement in local drainage conditions and shipping facilities is adapted to the culture of both general farm and intensively cultivated products.

The sand group of the province is represented by the sand of the San Luis series, no material of this texture having been encountered under the other series of soils recognized within the province. The soil is of loose, porous structure and is underlain by a stratum of porous gravel. The surface is wind blown, and much labor is necessary in leveling and preparing the land for cultivation. The soil occurs in areas of gentle slopes, but subdrainage is excessive, except in lower lying districts subject to a high water table. The soil is deficient in moisture-retaining capacity and subject to drought, except under conditions of frequent and abundant irrigation. Much of the lower lying areas are not suitable for farming purposes, owing to the accumulation of seepage waters and alkali salts from excessive irrigation upon the higher lying slopes. The type is utilized for the production of small grains, principally wheat and oats, and for the culture of Canada field peas. It is not as well suited to general farming as the soil groups of heavier texture. Small fruits and vegetables may be grown for home use, but climatic conditions are unfavorable to the commercial production of any but the more hardy vegetables and fruits.

The sandy loam group of soils covers extensive areas and is represented in the Alamosa and San Luis series, both of which are confined to the San Luis Valley in Colorado. The sandy loam of the San Luis series covers the most extensive areas.

The soils of this group are of porous character and, like the representative of the sand group, are underlain by a porous gravelly stratum. The soil is moderately coherent when moist and is friable under cultivation and easily maintained in a mellow condition of structure. It requires only a comparatively light farming equipment. The surface is sometimes wind blown and requires leveling in preparing the land for irrigation, but it is generally of more regular character than that of the sand occurring in the province. Subdrainage is good under favorable conditions of slope, but surface drainage is deficient over the areas of sandy loams, where the water table is encountered at shallow depth. Alkali salts occur in concentrations injurious to crops. Drainage is more unfavorable to utilization of the soils than in the sand group of soils in this province, but under favorable conditions of irrigation and drainage the soils are more retentive of moisture, require less excessive and less frequent applications of water, and are better adapted to farming purposes. Small grains, potatoes, Canada field peas and other forage crops, and sugar beets are the principal products. The poorly drained areas, where free from injurious accumulations of alkali salts, are devoted to the production of wild hay. The sandy loams are also suited to the production of such hardy small fruits and vegetables as may be grown in the locality in which these soils occur.

Soil of fine sandy loam texture has not been extensively encountered in this province. It has been recognized only in areas of limited extent, occurring under the Fruita series in the Grand Junction area, Colorado. The surface is gently sloping or nearly level, and, aside from the occurrence of occasional deeply eroded gullies or stream channels, is of smooth contour and easily prepared for the distribution and application of irrigation water. Surface and subsoil drainage are only moderately developed, and in places injurious accumulations of seepage waters from irrigation, accompanied by excessive quantities of alkali salts, occur. The soil is sticky when wet, but is readily maintained in a favorable condition of tilth under conditions of adequate drainage and proper cultivation. It requires a moderately heavy farming equipment. Climatic conditions in the locality in which the soil has been mapped are favorable to the culture of a wide range of general farm and intensively cultivated products, and under favorable conditions of drainage the soil constitutes a highly esteemed

type of wide adaptation. It is not so well suited to early stone fruits or early vegetables as soils of lighter texture and of more pervious character, but is better adapted to general farming purposes and to apples, pears, the later stone fruits, and staple vegetables. Apples, pears, alfalfa, sugar beets, wheat, and oats are the principal products grown.

Soils of the loam group have been encountered under the San Luis and the Fruita series. Those of the latter series are inextensive and those of the San Luis series occur in but moderately extensive areas. The soil material is of rather compact structure, is distinctly tenacious when wet, and assumes an intractable, puddled condition under unfavorable drainage and cultivation. A heavy farming equipment is required for effective utilization. The surface is generally smooth, comparatively level, and well suited to the practice of irrigation. Drainage is poorly developed and much of the areas covered by the loams are subject to injury from excess of underground or seepage waters and from accumulations of alkali salts. The soils are limited to a narrower zone in adaptation to crops than is the fine sandy loam of the province, but under favorable conditions of irrigation and drainage are suited to the culture of alfalfa, grass crops, small grains, and sugar beets.

A gravelly phase of the loam group of soils occurs in the gravelly loam member of the Bridger series, encountered in the Gallatin Valley, Mont. This phase departs widely from the normal loams of the province in features of structure, topography, and drainage. It occupies débris aprons and alluvial fans of good slope. Drainage is well established and frequently excessive, and the soil is free from the accumulation of alkali salts. It is of more porous structure than the normal loams and is of friable character, but is generally underlain by a rather heavy, compact subsoil and is moderately retentive of moisture under cultivation. It is utilized mainly for the production of grains without irrigation. Alfalfa is grown under irrigation to a limited extent. The soil is well suited to general farm crops under favorable conditions of moisture, but, owing to its porous, gravelly character, it is less well suited to dry farming during seasons of deficient rainfall than are soils of less pervious structure. Hardy fruits, small fruits, and vegetables should succeed in districts where the local climatic conditions are less severe.

The soils of the clay loam group occur under the Alamosa, Bridger, and the Cedaredge series, the last mentioned being represented only by this type. Conditions of topography, drainage, climate, the character of the substratum, and the relation of soils to agriculture vary widely in the three members of this soil group. The soils contain a large amount of organic matter. They are tenacious when wet and, under favorable conditions of drainage and cultivation, tend to puddle and bake and assume a refractory structure. They require a heavy farming equipment for economical and effective cultivation, and careful management and thorough tillage is necessary to maintain a favorable condition of tilth.

The clay loams of this province are generally well adapted to irrigation. In the member of the group occurring under the Bridger series, surface drainage is well established. The subsoil is of heavy, compact character, which prevents rapid subdrainage and renders the soil retentive of moisture. In the Cedaredge and Alamosa series the clay loams are characterized by poorly developed surface drainage, and generally by a high water table. Artificial drainage is essential to the effective development and utilization of the soils in lower lying areas. Where favored by conditions of drainage and irrigation, the soils are adapted to general farm products, including alfalfa, clover, grass crops, and grains. Sugar beets may be successfully grown where local climatic conditions permit complete development and maturing of the crop and where the product may be handled economically. Late vegetables and small fruits could be grown, except in the localities of more severe climatic conditions. Grains and native hay are the principal products, but in general the clay loam group of soils is restricted to rather narrow limits in adaptation to crops and is best suited to heavy general farming purposes.

Sand Group.

San Luis sand.—The soil is a coarse to medium, incoherent, loose, reddish-brown sand containing a large proportion of gravel and underlain at a depth of from 2 to 4 feet by a coarser material which can not be penetrated with the auger. The soil is composed of minute fragments of volcanic rock and is light and easily shifted by the wind. The generally level surface is crossed by minor ridges, and dunes from 1 to 6 feet high occur. These irregularities are a great

hindrance to cultivation and irrigation. The drainage is excessive, and constant irrigation is necessary. This has swamped some areas and brought about the rise of alkali over large tracts of the type. Areas which were originally productive have been abandoned for this reason. Fair crops of the small grains are grown. The yields per acre of wheat range from 15 to 30 bushels; of oats, from 20 to 40. Field peas are grown for pasture and for hay.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
San Luis sand	Colorado 4	136,960

[1] For key to number in this column see p. 733.

Sandy Loam Group.

Alamosa sandy loam.—The soil is dark brown to black and of porous, friable structure. The subsoil is of dark-gray to dark-brown color and is underlain, usually at a depth of about 2 feet, by a stratum of water-worn gravels and sand. The type occupies flat or gently sloping river plains and lower terraces along streams traversing low, broad alluvial fans. The surface material is derived predominantly from volcanic rocks. The members of the series are devoted mainly to native hay and potatoes, but under favorable climatic, drainage, and irrigation conditions are adapted to alfalfa, potatoes, grains, forage crops, and vegetables.

San Luis sandy loam.—The soil is a coarse, gravelly, reddish-brown sandy loam from 18 inches to 3 feet deep, with a subsoil of gravel and sand which extends to indeterminate depths. Near the mountains the surface soil is shallower, more sticky, and the gravel larger and more water worn. Heavier phases of the soil are known locally as "adobe." The type occupies imperceptibly sloping plains, the surface of which is broken by many knolls and ridges from 8 inches to not more than 2 feet in height. Near the mountains the soil is well drained and free from alkali, but the lower areas are filled with alkali. Nearly all the cultivated areas are sown to cereals and peas. The soil is well adapted to these crops and to potatoes and truck.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
San Luis sandy loam	Colorado 4	196,992
Alamosa sandy loam	do	35,776
Total		232,768

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

Fruita fine sandy loam.—The soil is a reddish-brown fine sandy loam, 6 feet or more in depth, interstratified with layers of sand and loam. It is of a friable, porous structure and has a slightly sloping or nearly level, smooth surface, cut by washes formed by intermittent streams. The type consists mainly of alluvial material derived from wash from sandstones and higher lying mesa lands, deposited over intermittent stream-formed fans. It is subject to considerable damage from alkali and seepage waters, but when well drained and free from alkali it is adapted to alfalfa, sugar beets, fruit, and truck crops.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Fruita fine sandy loam	Colorado 1	3,968

[1] For key to number in this column see p. 733.

LOAM GROUP.

Fruita loam.—This type is similar in color, topographic and drainage features, origin, and mode of formation, to the Fruita fine sandy loam. It consists of a sticky loam of compact, adobe structure, from 1 to 3 feet in depth, resting upon silt loam. The soil possesses marked puddling tendencies and bakes upon exposure. The type occurs in local depressions or upon lower slopes. It is generally poorly drained and filled with alkali, but when well drained and free from alkali it is adapted to alfalfa, grains, and general farm crops.

San Luis loam.—The soil is a plastic and sticky reddish-brown loam, containing some gravel, 24 to 36 inches deep, with a subsoil of sand or sandy loam, beneath which sand and gravel occur. The surface is level and uniform and adapted to irrigation. The soil contains alkali and is not at present extensively cultivated. When irrigated it produces good crops of wild hay and is adapted to the grain crops.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
San Luis loam	Colorado 4	9,088
Fruita loam	Colorado 1	512
Total		9,600

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

Bridger gravelly loam.—This consists of a rather fine sandy loam or loam, from 1 to 3 feet deep, carrying coarse, sandy material composed of fine angular rock fragments, giving it a somewhat loose, porous structure. The soil has a sticky, compact subsoil of fine texture and lighter color, although in the vicinity of canyon streams it is sometimes underlain by gravel and bowlders. The type occurs as small, local to broad, extensive areas covering mountain footslopes and alluvial cones and fans. The surface is dissected by minor streams, broken by rock outcrop or marked by glacial débris and bowlders. The soil and subsoil are generally gravelly, the gravel consisting of angular to partially rounded fragments. The soil is well drained and free from alkali, but is somewhat deficient in organic matter. It is dry farmed to grains and when irrigated produces grain, alfalfa, and fruits.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Bridger gravelly loam	Montana 2	12,544

[1] For key to number in this column see p. 733.

CLAY LOAM GROUP.

Alamosa clay loam.—The soil is dark brown to black and carries a high content of organic matter. It is very sticky when wet, is readily puddled, and bakes and checks upon exposure during dry periods. The upper subsoil is similar in color, texture, and structure to the soil material, but is underlain at a depth of 2 to 6 feet by a porous stratum of rounded gravels and river-laid sands. The soil is of alluvial origin and occurs upon level or very gently sloping areas of bottoms and lower terraces of streams traversing low, broad alluvial cones. It is derived mainly from volcanic rocks. Drainage is poorly established and the type is utilized for pasture and for the production of wild hay. When favored by drainage and climatic conditions it is, under efficient cultivation, adapted to alfalfa, grains, sugar beets, and hardy vegetables suited to rich, heavy soils.

Bridger clay loam.—The soil is a dark-colored to black, tenacious clay loam, from 1 to 3 feet in depth, of a fine silty texture, and of compact, adobelike structure, carrying considerable fine, angular gravel. The subsoil is a tenacious silty clay loam of light-yellow to gray color, carrying large quantities of lime. The type occurs as irregular areas covering parts of sloping terraces adjoining mountain ranges, foothills, and foot slopes. The soil is retentive of moisture and is productive either when dry farmed or irrigated.

Cedaredge clay loam.—The soil is a dark-brown to black clay loam of silty character, from 12 inches to 3 feet in depth, carrying a large amount of organic matter and underlain by a mottled gray, yellow, and drab silty clay loam which extends to a depth of from 3 to 5 feet, where it rests upon gravel. Gravel and bowlders occur upon the surface or in the soil or subsoil. The type is rather poorly drained and subject to a high water table. It is of inextensive occurrence and occupies gentle slopes or nearly flat local depressions in local stream valleys. It is friable under cultivation and supports a good growth of native grasses throughout the summer season. When drained and irrigated it is adapted to the production of truck, small fruits, and general farm crops. It is free from alkali but is not extensively utilized.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Alamosa clay loam	Colorado 4	23,104
Bridger clay loam	Montana 2	1,472
Cedaredge clay loam	Colorado 5	576
Total		25,152

[1] For key to numbers in this column see p. 733.

LAKE-LAID MATERIAL.

Soils derived from the lake-laid material in the Rocky Mountain region have been recognized only in the silt loam member of the Manhattan series, no other type under this series having as yet been encountered. This, in so far as mapped, occurs only in the Gallatin Valley, Mont., where it covers extensive areas of comparatively level plains traversed by deeply intrenched valleys of the perennial streams and by deep, narrow ravines, valleys, and gullies traversed by intermittent stream courses. Drainage is generally well established. The material from which the soil is formed consists of sedimentary deposits in extinct lakes, derived from erosion of areas covered by a variety of rocks of sedimentary and igneous origin, and including volcanic ash deposited directly in the waters or eroded from subaerial accumulations. The surface contour is generally favorable to irrigation, but owing to the occurrence of narrow, deeply cut recent valleys and ravines, irrigation through gravity systems is difficult. It is necessary in constructing irrigation canals and ditches to follow sinuous, meandering courses or to build expensive flumes or siphons crossing intrenched valleys. The soil of this province is extensively utilized, both with and without irrigation, but the results obtained under irrigation are more certain and profitable. Climatic conditions are prohibitive of the commercial culture of any but the hardier intensively cultivated crops, but both soil and climate are favorable to the production of grain and hay products.

DESCRIPTION OF THE SOIL SERIES.

Manhattan series.—The soils of the Manhattan series are light brown to brown. The upper portion of the subsoil, occurring at a depth of 5 to 12 inches, is of brown color and compact structure. The lower subsoil is of light-brown or gray color, silty texture, and is calcareous, of friable structure, and easily eroded. The types occupy sloping, well-drained, plateaulike plains, deeply eroded by stream valleys and by intermittent stream courses. The members of the series are derived from water-laid deposits of extinct lakes, consisting of sediments eroded from areas of crystalline sedimentary and eruptive and metamorphic rocks, with an admixture of volcanic ash deposited

directly in the lake waters or eroded from adjacent land areas. The soils are adapted to grains, and under irrigation to alfalfa and sugar beets. Under favorable climatic conditions they are suited to fruits.

Area and distribution of the soil of the Manhattan series.

Soil name.	State or area.[1]	Acres.
Manhattan silt loam	Montana 2	53,824

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The silt loam of the Manhattan series is the sole representative of the soils of the Lake-laid province in the Rocky Mountain region. It is a well-drained soil type, retentive of moisture under cultivation, and is suited to the practice of both dry farming and irrigation. It is sticky when moist and has a tendency to puddle and bake if tilled when wet, but under favorable conditions of drainage and culture is capable of being maintained in a mellow, friable condition of tilth. It requires a moderately heavy farming equipment. It is somewhat subject to erosion along the more pronounced slopes during heavy rains or excessive irrigation when unprotected by native sod or by cover crops or where traversed by irrigation ditches of high gradient.

The character of the soil is such as to render it suitable to a wide range of purposes, but climatic conditions limit its utilization. It is adapted to general farming of a rather heavy type, and is one of the most productive and important soils of the region for such purpose. Wheat, oats, and barley are the principal products. Alfalfa is grown to some extent under irrigation, and clover, timothy, forage crops, and hardy root crops can be grown under suitable local drainage and irrigation conditions. The more hardy vegetables and small fruits can be grown locally where provision is made for natural or artificial protection from frosts, but climatic conditions are not favorable to the extensive development of fruit-producing or trucking industries.

Silt Loam Group.

Manhattan silt loam.—The soil is of light-brown to buff color and of friable character, although sticky when wet. The upper subsoil is a light-brown, compact material, which gives way to a friable, calcareous deeper subsoil of lighter brown or gray color. Water-worn gravels occur in the vicinity of terrace lines. The type occupies sloping to eroded broad benches or plateaulike plains, deeply cut with ravines and marked by terraces. It is derived from early lake sediments from sedimentary, crystalline, and eruptive rocks and from volcanic ash deposits. The soil is well drained and retentive of moisture under cultivation, but deficient in organic matter content. It is utilized mainly for the production of grains, but under irrigation is adapted to alfalfa, clover, forage, and root crops, including sugar beets.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Manhattan silt loam	Montana 2	53,824

[1] For key to number in this column see p. 733.

RIVER FLOOD PLAIN MATERIAL.

The total area of the soils of the River Flood Plain province in the Rocky Mountain region is comparatively inextensive. In the limited number of areas covered by the soil survey, which has been confined to the older or more highly developed agricultural districts, these soils occupy a prominent position and

constitute one of the most extensive and important soil provinces of the region. They are more conveniently situated with regard to water supply for irrigation than are the soils of the other provinces, and the character of the surface is such as to favor the distribution of irrigation water. Some of the soil series occupy elevated terraces and are characteristically well drained and free from overflow, while other series are poorly drained or subject to overflow and sometimes contain injurious accumulations of alkali salts. The lower lying soil areas often support a growth of timber and brush, while those occupying the more elevated terraces are usually destitute of trees and characterized by desert vegetation.

Owing to convenient water supply for live stock, domestic use, and irrigation purposes, to the frequent occurrence of timber available for fuel and building purposes, and to native grasses suitable for pasture, the soils of the alluvial flood plains and terraces were generally among the first of the region to be settled and developed to agriculture.

In certain areas the regional and local climatic conditions have proven favorable to the culture of fruit, truck, or other special products. In much of the region the stream valleys form the most practicable routes in the construction of railway lines, and with the development of transportation facilities stock raising and the practice of general farming have been to a great degree displaced by an intensive system of agriculture.

The soils of the province, as recognized, occur under a number of soil series varying widely in character of the parent material from which the sediments are derived. The exact source of material is in many cases difficult to determine, but, where not apparent from inspection of the mineral particles of the soil material in the field, can generally be inferred with a reasonable degree of certainty from a general knowledge of the geological character of drainage basins and of the areas traversed by the streams. The soil series of the province are also subject to a diversity of conditions with respect to climate, drainage, character of subsoils or other underlying material, relation to irrigation, and to other influences which correspondingly affect or determine the present status of agriculture and the purposes for which the soils may be profitably utilized.

Some of the series have been encountered only in single areas surveyed, while others are more widely distributed. The soils of the more northern areas occurring under the Gallatin, Laramie, and Bozeman series are subject to restricted limitations, owing to prevailing climatic conditions or to limited water supply for irrigation purposes. They are utilized for the production of live stock and of general farm crops. The soils of the more southern areas occurring under the Grand, Mesa, Billings, and Uncompahgre series are devoted to a wide range of crops, including general farm products, fruits, melons, and sugar beets, and embrace much of the highly developed and intensively cultivated portions of the areas in which they occur.

DESCRIPTION OF THE SOIL SERIES.

Billings series.—The soils of the Billings series are gray to drab. The subsoils resemble the soils in color, structure, and texture, but sometimes rest upon a deeper stratum of stratified fine sandy deposits. The series is derived mainly from shales and sandstones and consists typically of stream-laid deposits occupying lower stream terraces. It includes, however, some alluvial surface deposits derived by surface wash from slopes occupied by shales or shale-formed soils. Drainage is fairly well established. The heavier types of the series are of compact, impervious character, in which case subdrainage is restricted, and some of the lower-lying bodies are subject to excess seepage waters from irrigation and to alkali salts. The soils are rarely subject to overflow. The surface is frequently eroded or gullied, but otherwise favorable to irrigation and cultivation, and under favorable conditions of irrigation, drainage, and climate the series is adapted to a wide range of general farm crops, sugar beets, fruits, and vegetables.

Area and distribution of the soils of the Billings series.

Soil name.	State or area.[1]	Acres.
Billings fine sandy loam	Colorado 1	26,944
silt loam	do	5,632
clay loam	Colorado 1, 5	4,544
silty clay loam	Colorado 5	3,200
clay	Colorado 1, 5	3,200
silty clay	Colorado 5	52,480
Total		96,000

[1] For key to numbers in this column see p. 733.

Bozeman series.—The Bozeman soils are brown to nearly black, the subsoils being dark brown in color. The subsoils seem to have a stratified structure and may be heavier or lighter than the soil, depending somewhat on the type. The deep substratum is gravelly. The topography is that of a lowland plain, some portions of which are thoroughly and others but slightly dissected. The material is of alluvial origin and is derived from a variety of rocks. The subsoils are generally calcareous.

Area and distribution of the soil of the Bozeman series.

Soil name.	State or area.[1]	Acres.
Bozeman silt loam	Montana 2	76,608

[1] For key to number in this column see p. 733.

Gallatin series.—The members of this series occur as small, irregular to broad, extensive areas. The lighter members are of a light-gray color and porous structure and contain gravel, consisting of well-rounded pebbles. The heavier members are grayish-blue or brown to black in color, compact in structure, usually poorly drained, sticky when wet, and have a tendency to puddle. The surface soils are underlain by light-gray or yellowish, ashy to dark subsoils of a compact, adobelike structure. Beds of gravel and cobbles partially cemented by lime occur at a depth of from a few inches to a few feet. The series occupies low, nearly level or slightly sloping stream terraces or alluvial river bottoms bordering stream channels. The areas are marked by shallow beds or channels of meandering streams, and in the vicinity of streams are timbered or covered with willow or brush thickets. The soils are formed by recent flood-plain deposits. The members of this series are derived mainly from basaltic, andesitic, or other volcanic rocks, with an admixture of material derived from granite, gneiss, sedimentary, or altered sedimentary rocks. They are generally rich in organic matter and of a mucky consistency, except in the lighter, higher lying members. The areas are subject to overflow, and the soils contain accumulations of alkali. They are devoted to hay, grains, vegetables, and pasture.

Area and distribution of the soils of the Gallatin series.

Soil name.	State or area.[1]	Acres.
Gallatin fine sandy loam	Montana 2	6,464
gravelly loam	do	32,576
silt loam	do	23,808
clay loam	do	896
Total		63,744

[1] For key to number in this column see p. 733.

Grand series.—The soils of the Grand series are of dark-gray to brown color, becoming nearly black when wet, where considerable quantities of organic matter are present. Some of the members are of reddish-brown tint. The sub-

soils are of gray to brown color, and of lighter tint than the surface material. A substratum of rounded gravel with interstitial sand of fine to coarse texture occurs at a depth of from 2 to 6 feet. The series occupies stream bottoms and lower terraces. It is of alluvial origin and is derived predominantly from quartz-bearing crystalline rocks, but is subject to some admixture of other material, principally from shales and sandstones. The surface is level or slightly sloping and is marked by slight ridges or by sloughs, remnants of former stream channels of the flood plain, or gullied by minor intermittent streams. Drainage is generally well established, except over lower lying bodies which are poorly drained or subject to overflow and to the accumulation of alkali salts. Where well drained and free from overflow the soils of the series are productive under favorable climatic conditions and under irrigation. The Grand series constitutes an important group of soils which are devoted to the production of grains, potatoes, vegetables, and sugar beets. Where sufficiently drained, the soils are also adapted to tree fruits and alfalfa.

Area and distribution of the soils of the Grand series.

Soil name.	State or area.[1]	Acres.
Grand fine sand	Colorado 1	3,008
sandy loam	Colorado 1; Wyoming 1	32,512
loam	Colorado 5	4,416
silty clay loam	Colorado 5	6,464
Total		46,400

[1] For key to numbers in this column see p. 733.

Laramie series.—The soils of the Laramie series are light brown or grayish brown, with a slight reddish cast. The subsoils are lighter gray or more reddish, sometimes becoming yellowish gray, and are generally heavier in texture and more compact in structure than the surface material. At a depth of from 2 to 6 feet or more the subsoil is underlain by deposits of sand or sandy loam with gravel, which often directly underlie the surface soil. Subangular to rounded pebbles, gravel, and small bowlders occur in variable quantities in the soil and scattered over the surface. The fragments are mainly of hard, fine-grained sandstone or of light-colored siliceous rocks, and are coated with lime, but the finer fragments include some granitic or feldspathic material. The series is derived from old alluvial terrace stream deposits of Pleistocene to relatively recent age, and occurs upon broad, sloping to elevated, rolling, treeless plains, dissected by minor stream courses, occasionally eroded, and broken by outcrops of a substratum of sedimentary rocks.

Area and distribution of the soils of the Laramie series.

Soil name.	State or area.[1]	Acres.
Laramie gravelly sandy loam	Wyoming 1	19,200
fine sandy loam	do	86,272
Total		105,472

[1] For key to number in this column see p. 733.

Mesa series.—The soils are pinkish red or reddish gray to light reddish brown. The subsoils are of lighter reddish-gray or gray color and generally of heavier texture and more compact structure than the surface material. The deeper subsoils are calcareous and contain noticeable amounts of gypsum. They are underlain at from 3 to 6 feet or more by stratified beds of water-worn gravel with light-colored interstitial material, which is calcareous and of rather coarse sandy nature. The gravel substratum immediately underlies the surface soil, locally approaching the surface. The pebbles appearing in the soil material or scattered over the surface are derived from a variety of the harder rocks. The gravel substratum is underlain by light-colored Cretaceous shales or sandstone, but these do not usually occur within 6 feet of the surface. The series is well

drained, except where the underlying shales closely approach the surface or where locally affected by seepage waters from irrigation. It occupies extensive, comparatively flat or gently sloping to dissected mesa lands or remnants of early water-laid stream terrace deposits. The soils are of arid, treeless character, and where capable of irrigation are extensively devoted to fruits and to alfalfa and other general farm crops.

Area and distribution of the soils of the Mesa series.

Soil name.	State or area.[1]	Acres.
Mesa fine sandy loam	Colorado 1	34,432
loam	Colorado 5	6,528
gravelly loam	do	18,112
clay loam	Colorado 1, 5	61,440
Total		120,512

[1] For key to numbers in this column see p. 733.

Uncompahgre series.—The soils are reddish gray to reddish brown and underlain by brown or reddish-brown, frequently calcareous subsoils, resting upon river sands and gravels at depths of less than 6 feet. They occupy rather low lying, flat to gently sloping flood plains of rivers or of narrow valleys traversed by minor tributary creeks, and are occasionally subject to overflow or to the accumulation of seepage waters and alkali salts. The soils are of recent alluvial origin, derived principally from shale and sandstone material. They usually support a growth of greasewood or other desert shrubs, and under favorable conditions of irrigation and drainage are adapted to grains, alfalfa, and sugar beets.

Area and distribution of the soils of the Uncompahgre series.

Soil name.	State or area.[1]	Acres.
Uncompahgre loam	Colorado 5	2,880
gravelly loam	do	576
Total		3,456

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Fine Sand Group.

The fine sand group of soils in this province is represented by the fine sand of the Grand series.

This has been recognized as bodies of limited extent occurring in but a single area surveyed. The soil is of pervious structure, is underlain by a porous stratum, and is deficient in moisture-retaining capacity. It occupies low terraces or stream flood plains, where it is subject to overflow or to a high water table. The surface is irregular and supports some timber growth, but the expense of clearing and preparing for irrigation is moderate. The soil is easily maintained in a mellow condition and requires only light and inexpensive farm machinery and draft stock for economical utilization. Lower lying areas, in which underground water is encountered at shallow depths, are not adapted to tree fruits, alfalfa, or other deep-rooted crops unless improved by drainage. The soil is not suited to heavy farming. It is adapted to melons, early truck crops, and, in well-drained areas, to early stone fruits. It is not so well adapted to apples and pears as the heavier textured soils, although the pear will succeed better where drainage is poor and alkali salts occur than the apple or the stone fruits. Truck crops are the principal products.

Grand fine sand.—The Grand fine sand is reddish brown. The subsoil is similar in color and texture to the surface soil, but is underlain at from 1 to 6 feet by a substratum of rounded gravel with interstitial sand. The type is of loose,

open, porous structure, is readily permeated by water, and easily cultivated. It is, however, less retentive of moisture than the heavier members of the series, but more frequently occupies a low-lying position, where it is subject to overflow during periods of flood, to poor drainage, owing to a natural high water table, or to seepage from the irrigation of higher lying soils. The type occupies stream bottoms and lower terraces. The soil is of alluvial origin, and is derived mainly from quartz-bearing crystalline rocks with an admixture of material from sedimentary rocks. The surface is slightly irregular or marked by abandoned stream channels, but is capable of being readily prepared for irrigation. The soil material is deficient in organic matter. Under favorable conditions of irrigation and drainage the type is utilized principally for the production of truck crops. Where the water table is not too high tree fruits and alfalfa can also be grown. The soil is best adapted to early truck crops and, where favored by subdrainage, to early stone fruits.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Grand fine sand	Colorado 1	3,008

[1] For key to number in this column see p. 733.

Sandy Loam Group.

Like the fine sand group, the sandy loam group of soils is represented by a single member occurring under the Grand series. This covers comparatively inextensive areas of the river flood plains and terraces, but is more widely distributed than most soils of the province. It has been encountered in the Grand Junction area, Colorado, and in the Laramie area, Wyoming, under widely divergent conditions of climate, drainage, economic environment, and agricultural utilization.

The surface is slightly irregular or marked by former stream-channel remnants and supports a native growth of brush or timber, but is well suited to irrigation practice and is capable of being prepared for cultivation and irrigation without great expense. The soil is of friable structure and is easily maintained in a good condition of tilth by the use of a light farming equipment. It is of porous character and the higher lying bodies are excessively drained. The lower lying bodies and most of the areas covered by the sandy loam in the Laramie area, Wyoming, are poorly drained and subject to the accumulation of seepage or drainage waters and alkali salts or to overflow from adjacent streams. The soil is somewhat more retentive of moisture under cultivation than the fine sand of the province occurring under the same series. It is better adapted to general farming and is capable of utilization for a wider range of products. In the Laramie area, Wyoming, it is devoted mainly to the production of native hay and small grains, but, where not too poorly drained, is adapted to potatoes and such hardy vegetables as may be grown under the prevailing climatic conditions. In the Grand Valley, Colo., it is used for the production of truck crops, sugar beets, berries, and tree fruits.

When occurring under favorable local climatic, drainage, and irrigation conditions the soil is suited to general truck crops, including cantaloupes, tomatoes, etc., and to early apples and pears, stone fruits, sugar beets, small fruits, alfalfa, and forage crops. Only the better drained areas are suitable for the culture of tree fruits and alfalfa, owing to the occurrence of underground water at shallow depths in much of the lower lying areas. The sandy loam is not so well adapted to grains or to grass crops, except in the more poorly drained areas, as are the soils of heavier texture.

Grand sandy loam.—The soil is brown to dark gray or black, being subject to considerable variation in color owing to range in organic-matter content, and its structure is loose and porous. The subsoil is similar in color, texture, and structure to the soil material, but is underlain at a depth of from 2 to 6 feet by sand and water-worn gravel. Where the gravel does not appear within a depth of 6 feet, the deeper subsoil is of sand. The type occupies stream bottoms and lower terraces. It is of alluvial origin and is derived predominantly from crystalline quartz-bearing rocks, although an admixture of material from sedimentary and other rocks occurs. The surface is slightly uneven or marked by

sloughs or remnants of former stream channels. The land is, however, quite easily prepared for irrigation. Where occupying a favorable position the type is well drained and rather deficient in moisture-retaining capacity. Owing to the low-lying position, however, it is frequently subject to an accumulation of seepage waters and to a resulting high water table and poor subdrainage. Alkali salts in injurious quantities appear in the poorly drained areas. The soil is friable and easily maintained in a good state of tilth. It is adapted to the production of truck crops, berries, and other small fruits. In the Northern States the type is utilized for the production of hay, although grains, potatoes, and garden vegetables are grown to some extent. The more southern areas are devoted to truck crops, small fruits, and sugar beets. Pears, peaches, apples, and alfalfa are also grown in areas favored by good subdrainage.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Grand sandy loam	Colorado 1; Wyoming 1	32,512

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam phase of the sandy loam group of soils in so far as recognized embraces but a single member mapped under the Laramie series of soils and encountered only in the Laramie area, Wyoming. This phase of the sandy loam group occurs as elevated alluvial terrace deposits, lying well above recent stream-laid sediments. It is of open, porous character, requires an abundance of water for irrigation, is deficient in moisture-retaining capacity, and is not well suited to dry farming. Climatic conditions prohibit the culture of any but the more hardy fruits or vegetables. Only inextensive portions of the area are capable of being irrigated, and owing to this restriction and to the porous, leachy character of the soil it is utilized mainly for grazing purposes. In the irrigated districts some of the lower-lying areas are subject to the occurrence of excess seepage waters and alkali salts. Native hay, timothy, and grass crops are grown to some extent in local poorly drained areas. Alfalfa and grains may be grown under frequent and copious irrigation, but the soil is not well suited to general farming. It covers quite extensive areas, but is of minor agricultural importance.

Laramie gravelly sandy loam.—The soil is of sandy loam texture and carries a large quantity of gravel, varying in size from small pebbles to cobbles, with some small bowlders. It is underlain at a depth of from 2 to 3 feet by a lighter sandy loam or sand with gravel, the gravel usually increasing in size with depth. The soils and subsoils are shallow and shale and limestone formations occur at depths of less than 6 feet, particularly in the vicinity of local depressions occurring over plains and occupied by lakes. The type occupies higher areas of the older terrace deposits of Pleistocene age. The topography varies from relatively level to broken and hilly and is marked by bluffs of shales and limestones. The soil is of porous structure, is deficient in moisture-retaining capacity, and is not adapted to farming without irrigation.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Laramie gravelly sandy loam	Wyoming 1	19,200

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loam group of soils includes a number of members occurring under the Billings, Gallatin, Laramie, and Mesa series. These various members of the group have been mapped in widely separated areas under a diversity of conditions of topography, drainage, climate, and irrigation and agricul-

tural development. The soils cover extensive areas of the river flood plains and terraces. Those of the Laramie, Gallatin, and Mesa series are confined to the older alluvial terraces or elevated terraced valley plains. That member occurring under the Billings series occupies a somewhat lower lying position, but occurs upon terraces and valley slopes lying well above present flood plains, and areas of importance are rarely subject to overflow. Drainage is well established, but lower-lying slopes or flats are subject to the accumulation of seepage waters from irrigation and in the more arid districts to injurious concentrations of alkali salts. The character of the surface is rather variable, but is favorable to the distribution and application of irrigation waters.

The fine sandy loams are of more compact character than the sandy loam occurring in the province, and are more retentive of moisture under cultivation. They are usually friable when cultivated and are quite readily maintained in a good condition of tilth by the use of moderate farming equipment. Under favorable conditions of irrigation, drainage, and culture they are well suited to general farming, and, where climatic conditions and marketing facilities are suitable, to the commercial production of apples, pears, cantaloupes, late peaches and other stone fruits, cucumbers and other staple vegetables for the late market or for preserving, and to sugar beets. The more northern areas are limited by climatic conditions mainly to the culture of general farm products, principally wheat, oats, and barley, while alfalfa, clover, grass crops, and potatoes are grown to some extent. Quite extensive areas occupied by the soils of this group are incapable of irrigation from gravity systems and are either devoted to dry farming to grains, or utilized for grazing. Without irrigation yields are rather light. The higher-lying soils, being underlain by a porous substratum, are less retentive of moisture and less well suited to dry farming than the soils of heavier texture or those occupying a lower-lying position and subject to conditions of more moderate surface and subdrainage.

Billings fine sandy loam.—The soil is light gray to brown, about 1 foot deep, and is underlain by light-colored fine sandy loam, sand, or gravel, imperfectly stratified. The soil sometimes extends to a depth of 6 feet or more, but with little change in texture or structure. It has a compact structure but is friable under cultivation. The type occurs upon gently sloping valley plains in the vicinity of bluff lines or rock outcrop and is cut by arroyos or gullies with perpendicular walls. It consists of old alluvial deposits modified by colluvial and alluvial wash from sandstone and shale material and from more elevated soil bodies. It is well drained and free from alkali and is adapted to alfalfa, sugar beets, fruits, vegetables, and general farm crops.

Gallatin fine sandy loam.—This type consists of a light-brown to light-gray fine sandy loam, rather light in texture, grading to a fine sand. The soil has a loose, friable structure to a depth of from 1 to 6 feet, and is underlain by a gray or light-colored fine sandy or silty subsoil, containing small, well-rounded gravel, which grades into beds of river sands and gravel. The sand and gravel beds sometimes underlie the soil directly. The type occurs in small, irregular to broad, extensive areas covering valley plains and low, nearly level to slightly elevated and sloping stream terraces. The surface is smooth, except in the vicinity of bluff or terrace lines or where cut by stream channels, and is treeless. The soil is often strewn with water-worn gravel or slightly drifted by winds. It is seldom subject to overflow, and is generally well drained and free from alkali, except when subject to seepage from more elevated soils. The soil is deficient in organic matter. Under irrigation it is adapted to grains, alfalfa, and clover, and to hardy truck, small fruit, or fruit products.

Laramie fine sandy loam.—The soil as mapped is subject to considerable variation in texture, but consists predominantly of a fine sandy loam in which a noticeable amount of coarse sand and small to fine gravel appears. These are prevailingly of quartz, but include some limestone and feldspathic fragments. In depth the soil ranges from 2 to 6 feet or more, the texture becoming heavier with increasing depth. The subsoil is a sand or sandy loam of light grayish-brown or yellowish-brown to reddish-brown color, carrying comparatively large quantities of gravel, although the underlying shales and limestones or heavy residual materials derived therefrom sometimes appear. The type occurs as comparatively level plains of wide, shallow stream valleys of recent date to rolling elevated alluvial plains of Pleistocene age. Numerous small to extensive basins without drainage occur, many of which are occupied by lakes and covered by heavy soils of residual origin, some of which have not been differentiated from the type in mapping. The type also includes limited areas of undifferentiated gravelly and sandy loams, loams, and heavy loams of the Laramie series. Drainage is good except in the vicinity of local flats or depressions which are

subject to accumulation of seepage water from irrigation or to concentration of alkali salts. Under favorable conditions of irrigation and drainage the soil is adapted to spring wheat, oats, barley, alfalfa, potatoes, and hardy vegetables.

Mesa fine sandy loam.—The soil is a reddish to chocolate-brown fine sandy loam, of light, friable character and porous, leachy structure, extending to a depth of from 4 to 20 feet or more, and underlain by shale and sandstone. The type occurs as elevated, level to broken and hilly mesa lands, often marked by gravel-strewn bluff lines. It consists of old flood-plain deposits derived from sedimentary, granitic, and volcanic rocks and modified by subsequent erosion and aeolian agencies. The soil, when within the reach of irrigation, is adapted to fruits and tilled crops.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Laramie fine sandy loam	Wyoming 1	86,272
Mesa fine sandy loam	Colorado 1	34,432
Billings fine sandy loam	.....do	26,944
Gallatin fine sandy loam	Montana 2	6,464
Total		154,112

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The soils of the loam group in this province are of more restricted occurrence than the fine sandy loams. They have not as yet been encountered in the more northern areas of the region, and prevailing climatic conditions are favorable to the culture of a wide range of fruits and vegetables. That member of the group occurring under the Mesa series occupies extensive elevated remnants of early terraces and is well drained, except where locally subject to the occurrence of seepage waters from irrigation. The other members of the group occupy stream bottoms and low terraces, in which surface and subdrainage is poorly developed.

The soil is of moderately heavy character, is tenacious when wet, and has a tendency to puddle and bake when poorly drained and improperly managed. Under favorable conditions of drainage and cultivation, it is of friable structure and may be maintained in a good condition of tilth, but it requires a somewhat heavier farming equipment and more careful management than the fine sandy loams. The loams are more retentive of moisture than the fine sandy loams, but prevailing climatic features do not favor the practice of agriculture without irrigation. They constitute a valuable group of soils for general purposes, and are utilized for a diversity of products. Where drainage and irrigation conditions are suitable they are very well adapted to general farming and to the production of the later fruits, small fruits, and vegetables. The lower lying areas are utilized for the production of sugar beets, grains, and vegetables, consisting mainly of potatoes, onions, lettuce, carrots, peas, etc. Strawberries and bush fruits are grown to a limited extent. Areas in which the water table closely approaches the surface are not suited to the culture of alfalfa or tree fruits. The higher lying and more thoroughly drained areas are devoted to the production of alfalfa, sugar beets, oats, potatoes, apples, peaches, and cherries.

The loams are adapted to the stone fruits where drainage is adequate. Under similar conditions of drainage and irrigation they are not so well adapted to early fruit or vegetable products as the soils of lighter texture, but produce heavier yields and are profitably utilized for staple fruits and vegetables for the later market or for preserving purposes.

Grand loam.—The soil of the Grand loam is of dark grayish-brown color and of rather light loam texture and friable structure. The subsoil resembles the soil in color, texture, and structure, and is underlain usually at a depth of from 2 to 6 feet by a stratum of rounded gravels with interstitial sandy material. The type occupies a low-lying position over recent bottoms and lower stream terraces. The soil is of alluvial origin and is derived mainly from quartz-bearing crystalline rocks, with an admixture of some material from sedimentary and other rocks. The surface is level to slightly sloping. Owing

to a high water table, the subsurface drainage is poor. The soil is usually well supplied with humus. It is retentive of moisture under cultivation, and requires less water in irrigation than the lighter members of the series. It is utilized for the production of potatoes, sugar beets, and truck crops, including onions, cabbage, lettuce, carrots, peas, and beans. Strawberries and bush fruits are also grown to some extent. Alfalfa and tree fruits, consisting of apples, pears, and peaches, can be grown in the better-drained areas.

Mesa loam.—The soil is a pinkish-red or pinkish-gray to light reddish-brown friable loam of light texture, becoming heavier with increasing depth, and extending to a depth of 3 to 6 feet or more. It is underlain by grayish-brown gravel or gravelly sandy loam. The lower portion of the subsurface soil contains gypsum or calcium carbonate, which imparts a lighter color to the soil material. Small quantities of gravel occur throughout the 6-foot section. The type occupies gently sloping, treeless areas. Drainage is good, except in local areas, where seepage waters accumulate. The soil is easily maintained in a friable condition of tilth and is retentive of moisture. It is adapted to truck crops, potatoes, alfalfa, sugar beets, grains, and fruits, particularly apples, peaches, and cherries.

Uncompahgre loam.—This is a reddish-brown to reddish-gray loam extending to a depth of 2 to 6 feet or more, underlain by river gravel. Small seams of sand occur throughout the soil section, but otherwise the texture is uniform, and but little variation in color occurs throughout the soil profile. The type occupies narrow valleys traversed by intermittent stream channels with perpendicular bluffs crossing elevated Mesa lands. It is subject to the occurrence of seepage waters and alkali salts, and is capable of being greatly improved by artificial drainage. The native vegetation consists principally of greasewood, and but a small proportion of the type is under cultivation. Where well drained, properly tilled, and free from alkali the soil is productive and adapted to sugar beets, grains, and alfalfa. Owing to a high water table and an unusual alkali content, it is not well suited to tree fruits, but certain bush fruits may be successfully grown.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Mesa loam	Colorado 5	6,528
Grand loam	do	4,416
Uncompahgre loam	do	2,880
Total		13,824

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase of the loam group of soils includes soils recognized under three series. One of these occurs in the Gallatin Valley, Mont., where it constitutes an extensive soil type utilized mainly for pasture and for the production of grains and hay. The other members of the group have been encountered in the Uncompahgre Valley, Colo., and are not of extensive occurrence or highly developed to agriculture.

The surface of the higher-lying bodies of the gravelly loams is irregular or broken and poorly adapted to cultivation or irrigation. That of the lower lying bodies is usually comparatively level, but sometimes broken by stream channels, low terraces, or by other irregularities. The soils are cobble strewn and contain sufficient cobbles and gravel to render the soil material of much more porous character than the normal loams of the province. The more elevated soil areas are excessively drained and deficient in moisture-retaining capacity, and require frequent applications of water in irrigation.

The gravelly loams are thin and underlain by a stratum of cobbles and gravels with but little interstitial material. The gravel content of the soil material is sometimes sufficient to interfere with cultivation. The soil is of friable character under cultivation and where not too gravelly or stony can be effectively cultivated by the use of a moderate farming equipment. These soils are not as well suited to general farming or to intensive agriculture as the loams, but where they are of sufficient depth, adequately irrigated, and favored by climatic

conditions, they are utilized to some extent for the production of alfalfa, wheat, oats, sugar beets, potatoes, and fruits. They are not so well suited to hay and grain crops or to sugar beets as the normal loams of the province, but under favorable local conditions of topography and irrigation are better adapted to early fruit products and more frequently occupy slopes favorable to air drainage and protection from frosts.

Gallatin gravelly loam.—The soil is a rather compact, moderately heavy and sticky loam of dark-gray to dark-brown color, varying from a few inches to 3 feet in depth and carrying a large quantity of flattened or rounded gravel, chiefly of basaltic or other volcanic rocks, from a fraction of an inch in diameter to the size of cobbles. The surface is often strewn with cobbles and gravel. The soil is underlain by a sticky, gravelly loam of fine texture and light-gray color, grading to gravel beds, or frequently underlain directly by beds of river sands and reworked pebbles and cobbles, partially cemented by lime. The type occurs as extensive areas covering nearly level or slightly sloping stream-flood plains or valley bottoms. The surface is broken by shallow stream channels or minor stream-formed terraces, and supports heavy thickets of willow and light timber. The soil is well drained, except in the level areas, which are subject to overflow. It is too shallow and gravelly for profitable cultivation, but the favorably situated areas are adapted to grains and hay.

Mesa gravelly loam.—The soil is of rather shallow character and carries varying amounts of water-worn gravel of medium size throughout the entire soil section. It is of pinkish-red to pinkish-gray color and is underlain by a bed of gravel with finer interstitial material at from 6 inches to 3 feet below the surface. The lower portion of the soil and the upper portion of the underlying gravel contain an excessive amount of lime. The type is well drained and free from alkali, except where the underlying shale closely approaches the surface or where locally affected by seepage waters. It is of treeless character and occurs as narrow bodies bordering the edge of elevated mesa lands. It is somewhat deficient in moisture-retaining properties, and its dissected or broken character renders tillage difficult. The soil is not extensively utilized, but where free from alkali and seepage waters is adapted to alfalfa, grains, and fruits.

Uncompahgre gravelly loam.—The soil to a depth of 12 inches is of reddish-brown to pinkish color, of medium texture, and is underlain by grayish loam or gravel, which rests upon a bed of gravel at a depth of 2 to 6 feet. Considerable gravel occurs throughout the soil section. The grayish color of the subsurface soil overlying the gravel is due to the presence of a high content of lime. Tillage is difficult, owing to excessive quantities of gravel. The type is well drained and free from alkali. It is of rather inextensive occurrence, but is suited to fruits, alfalfa, sugar beets, potatoes, and grains under irrigation.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Gallatin gravelly loam	Montana 2	32,576
Mesa gravelly loam	Colorado 5	18,112
Uncompahgre gravelly loam	do	576
Total		51,264

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

The soils of the silt loam group have been recognized under three soil series. Two members of the group occur in the Gallatin Valley, Montana, under climatic conditions most favorable to the production of hardy general farm crops. The other member of the group is confined to the Grand Valley in western Colorado, where the climate is favorable to the culture of a wide range of staple and special products.

The soils are of distinctly tenacious character when moist, and with poor drainage and improper culture tend to puddle and assume a refractory structure. Under such circumstances a condition of good tilth is maintained with difficulty, but under judicious management and adequate drainage the soils can be kept in a mellow, friable condition under cultivation. They demand a rather

heavy farming equipment for economical and effective cultivation. Both surface and subsurface drainage conditions are poorly developed in the lower lying areas. The silt loams are more retentive of moisture than the soils of lighter texture and are more economically irrigated and better adapted to dry farming.

These soils are restricted to a somewhat narrower range in adaptation to crops than the soils of the fine sandy loam and loam groups of the province. They are best suited to general farming, but under favorable climatic, drainage, irrigation, and economic conditions are adapted to sugar beets and to late fruit and vegetable products. In the northern areas they are utilized for the production of grains, timothy, clover, and wild hay, and for pasture. In the more southern localities they are used mainly for the culture of alfalfa, sugar beets, grains, and to some extent for potatoes, apples, and pears. They are not adapted to early truck crops or to stone fruits or early small fruits.

Billings silt loam.—The soil is a light-gray to dark-brown silt loam, generally 3 feet or more in depth, underlain by lighter or heavier subsoils, varying from sands to clays, which in turn are underlain by gravel. The soil is of compact, adobelike structure, is very sticky when wet, puddles readily, and bakes and checks upon exposure. It is friable under proper cultivation. The type occurs as a second-bottom soil along lower valley plains and adjacent to recent stream deposits. The surface is level, except for minor terrace lines, arroyos, and other old or intermittent stream channels. The lower lying bodies are often poorly drained and contain alkali, but otherwise the soil is adapted to sugar beets, grains, and alfalfa.

Bozeman silt loam.—The soil is a brown to nearly black, heavy, sticky silt loam of compact structure about 1 foot in depth. When poorly drained a refractory adobelike structure prevails, and small puddled and barren spots occur. The subsoil consists of a dark-brown, sticky, silty loam or clay loam of adobelike structure, underlain at 3 feet by stream gravel or by a light-yellow to light-gray silt loam of ashy texture. Medium fine to coarse rounded gravel and cobbles occur in both soil and subsoil. The type occupies irregular and extensive areas of treeless footslopes, elevated sloping plains, and sloping to nearly level valley plains. The lower-lying bodies are deficient in drainage and contain alkali.

Gallatin silt loam.—The soil is a dark-gray or brown to black, heavy, sticky silt loam containing gravel. It has a compact structure, but is friable under cultivation. The soil is from 10 to 36 inches deep, and is underlain by a dark-gray or black to light-colored, heavy, sticky silty loam of rather compact adobe-like structure, which extends to a depth of 6 feet or more and is in turn underlain by rounded river gravels. The type occupies small to extensive areas covering nearly level valley depressions, river flood plains, and stream bottoms. The areas are marked by willow thickets or small timber and are cut by meandering stream channels. The type is composed of stream sediments derived from mountain rocks and formed by the degradation and reworking of earlier lake beds. The soil is often subject to overflow, is poorly drained, and contains alkali. It is rich in organic matter and is frequently of a mucky consistency. It is devoted to pasture, hay, grains, vegetables, and forage crops.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Bozeman silt loam	Montana 2	76,608
Gallatin silt loam	do	23,808
Billings silt loam	Colorado 1	5,632
Total		106,048

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loam group of soils of the river flood plains and terraces in the Rocky Mountain region is represented in the Billings, Gallatin, and Mesa series. The clay loam of the Gallatin series is confined to the Gallatin Valley, Montana, that of the other series occurring in the Uncompahgre and Grand Valleys, Colorado.

The surface contour is favorable to the practice of irrigation where water supply is available for such purposes, but in the lower lying bodies drainage is poorly developed and the soils are subject to the accumulation of excess seepage waters and alkali salts.

The soils are of rather heavy, compact character, become sticky when wet, and assume a refractory condition of structure under conditions of inadequate drainage or inefficient tillage. Where well drained and thoroughly cultivated they generally acquire a friable structure and may be maintained in good tilth, but they require a rather heavy farming equipment. The type is retentive of moisture. It is adapted to general farming and the production of grain and grass crops, forage plants, root crops, and, where favored by irrigation and drainage, alfalfa. The better drained and more friable soils of the clay loam group are also valuable for fruit culture. In the Uncompahgre and Grand Valleys, Colorado, they are extensively utilized for the production of choice apples and pears. Under similar conditions of drainage, irrigation, climate, and tillage they do not differ greatly in adaptation to crops from the soils of the silt loam group.

Billings clay loam.—The soil is a gray to dark-brown or black, plastic clay loam, from 1 to 6 feet in depth, of heavy, compact structure, puddling when wet, and baking upon exposure. Where less than 6 feet deep it is underlain by clay and in the lower part of the section by coarse sandy loam, loam, or gravel. The subsoil is dark gray to black. The type occurs upon old stream-formed terraces and low, nearly level valley plains, and is marked by slough or stream channels, gullies, or swampy depressions. Small gravelly ridges occur in the vicinity of stream channels. The soil consists of shale and sandstone material, and is formed by old stream deposits and by alluvial wash from bluffs and higher lying soil bodies. With the exception of poorly drained and alkaline depressions and lower slopes, the soil is adapted to alfalfa, grains, sugar beets, and sometimes to fruits, potatoes, and late vegetables.

Gallatin clay loam.—This type consists of a dark chocolate brown, heavy, sticky clay loam of compact, adobelike structure, about 3 feet in depth, and underlain by a heavy, silty clay loam subsoil of lighter color, or by water-worn gravel. The soil puddles readily, bakes and cracks upon exposure, and carries small angular rock fragments. The type occurs as small bodies occupying local depressions in the vicinity of the valley trough and is poorly drained. It is composed of heavy stream alluvium, partially derived from the reworkings of earlier lake beds. The soil is devoted to grains and hay.

Mesa clay loam.—The soil consists of a stiff, plastic, refractory, and compact reddish to chocolate-brown clay loam, from 4 to 6 feet in depth, and underlain by sandy and gravelly material grading to shale and sandstone. The type occurs in depressions and is formed largely of the finer wash from the Mesa fine sandy loam. It is free from alkali, productive, and adapted to alfalfa, sugar beets, and grains.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Mesa clay loam	Colorado 1, 5	61,440
Billings clay loam	.....do	4,544
Gallatin clay loam	Montana 2	896
Total		66,880

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loams, in so far as recognized in this province, are confined to the Uncompahgre Valley, Colo.

The soils occupy a lower lying position than the normal loams and are of less friable character. They are subject to deficient drainage, with the occurrence of seepage waters and alkali salts, and to overflow. The surface is gullied and in the vicinity of stream channels a growth of brush and timber occurs. The cost of clearing and preparing the land for irrigation is greater than in case of the normal clay loams and the soils demand a somewhat heavier farming equipment, more thorough tillage, and more careful management.

Where favorable conditions of drainage are established a good condition of tilth may be maintained by judicious tillage, and the soils are suited to heavy general farming purposes, to the intensive culture of sugar beets, and to late or heavy vegetables, such as cabbage, onions, and late potatoes. They are utilized for the production of sugar beets, alfalfa, wheat, oats, potatoes, onions, and cabbage. Only the better drained areas are adapted to alfalfa. The silty clay loams are not utilized to any extent for the production of fruits and are not well adapted to this purpose. They are restricted to a much narrower range in crop adaptation than are the normal clay loams of the province.

Billings silty clay loam.—The soil is a compact silty clay loam of light grayish-brown color and uniform texture, extending to 6 feet or more, and underlain at from 1 to 6 feet by a clay loam. It is of rather compact structure and is readily puddled if cultivated when wet. The type is traversed by deep, narrow gullies and eroded by intermittent streams. It occupies moderate slopes below Cretaceous shale bluffs and hills. The surface is smooth and adapted to irrigation with but little leveling. The soil is composed largely of alluvial fan material and is derived from shales, with an admixture of material from soils of the Mesa series. It carries excessive quantities of alkali salts, and is locally subject to deficient drainage where affected by seepage waters. The native vegetation consists principally of greasewood and "shad scale." Under favorable conditions of drainage and irrigation, and where free from alkali, the soil is adapted to sugar beets, grains, potatoes, and alfalfa.

Grand silty clay loam.—The soil is a dark-brown silty clay loam, the silt content generally increasing downward to a depth of 3 to 6 feet, where river gravels are encountered. The type is subject to a high water table, deficient drainage, and to overflow during periods of flood. The soil is friable under favorable conditions of drainage and tillage, but contains alkali. The native vegetation consists principally of sage, greasewood, cottonwood, willows, and other underbrush, which render clearing somewhat expensive. The type is productive and adapted to sugar beets, wheat, oats, potatoes, onions, alfalfa, etc.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Grand silty clay loam	Colorado 5	6,464
Billings silty clay loam	do	3,200
Total		9,664

[1] For key to number in this column see p. 733.

CLAY GROUP.

The clay group of soils in this province is represented only by the clay of the Billings series, which has been encountered in the Grand and Uncompahgre Valleys, Colo.

The soil occupies the lower lying flats and depressions of river terraces and is deficiently drained and characterized by injurious accumulations of seepage waters and alkali salts. Artificial drainage is generally necessary in any extensive utilization of the land, and most of the soil areas are capable of improvement by such means. When so improved the soil is adapted to heavy farming and the production of grasses, grains, sugar beets, and, in the better drained localities, alfalfa. The poorly drained areas are used for pasture.

Owing to its compact, refractory structure, the soil demands a heavy farming equipment, deep plowing, and thorough preparation of the land in planting, with frequent subsequent cultivation in order to maintain a condition of tilth favorable to the development of crops. It is limited to a comparatively narrow range in adaptation to crops and is not suitable for the commercial production of fruit or truck products.

Billings clay.—The soil is a yellowish-gray to black clay, generally extending to a depth of 4 to 6 feet or more, but sometimes underlain at less depth by strata of dark-gray to black clay loam or loam, or by sand and gravel. It is of compact, refractory, adobelike structure, puddles readily, bakes and checks upon exposure, has an impervious nature, and is tenacious when wet. The type occurs upon old stream terraces and lower valley plains and in depressions marking swampy areas, former lagoons, or slough beds. The surface is nearly

level or only slightly sloping and is unmarked by gravel, except in the vicinity of upland bluff lines, where fragments of shales or sandstone may occur. The soil is rich in organic matter, but is poorly drained and alkaline. In origin and mode of formation it is similar to the Billings clay loam. It is adapted to pasturage, hay, grains, and sugar beets.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Billings clay	Colorado 1, 5	3,200

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

The silty clay phase of the soils of the clay group is represented by a single member occurring under the Billings series. This has been encountered only in the Uncompahgre Valley, Colo.

The surface is gently sloping and adapted to the distribution of irrigation water, but is sometimes badly gullied. The soil is of compact character, sticky when wet, and puddles and bakes under unfavorable conditions of drainage and culture. Drainage is, however, more thoroughly developed than in the normal clay of the same series, and the maintenance of a favorable condition of tilth is somewhat less difficult. Alkali salts in injurious concentrations are of common occurrence.

Where well drained, thoroughly tilled, and free from injurious quantities of alkali the silty clay loam is adapted to heavy general farming and, in the more favorably located areas, to the culture of sugar beets and late or heavy vegetables, such as cabbage, onions, cauliflower, carrots, etc. It is not so well suited to potatoes as are soils of lighter texture. Sugar beets, alfalfa, wheat, and oats are the principal products.

Billings silty clay.—This type consists of a light-grayish or grayish-brown silty clay, extending to a depth of from 1 to 6 feet or more. The subsoil is a grayish or grayish-brown silt loam or silty clay loam, underlain by Cretaceous shales. The soil and subsoil contain considerable quantities of gypsum and alkali salts. Owing to its heavy, compact character, the soil puddles if cultivated when too wet, and is tilled with some difficulty, but under favorable conditions of tilth and moisture it is of friable character. The type is of extensive occurrence, occupying nearly level to gently sloping and undulating areas. The surface is smooth, but marked by gullies, and is sometimes quite badly dissected. It is, however, easily prepared for irrigation. The type is derived mainly from shales or soils of the Chipeta series. It is treeless, but generally supports a heavy growth of desert shrubs. It is poorly drained, owing to the effects of seepage waters and to a high water table. Under favorable conditions of irrigation and when well drained and free from alkali, the soil is well adapted to grains and leguminous crops and to certain truck crops suited to the heavier soils, particularly cabbage and related products. It is less well adapted to fruits and potatoes than the lighter members of this series.

Area and distribution of the silty clay.

Soil name.	State or area.[1]	Acres.
Billings silty clay	Colorado 5	52,480

[1] For key to number in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough broken land	Colorado 5	34,432
Swamp	Montana 1	3,008
River wash	Colorado 5; Wyoming 1	2,432
Gypsum	Wyoming 1	2,304
Total		42,176

[1] For key to numbers in this column see p. 733.

Key to the Soils of the Rocky Mountain Plateau and Plains Region.

- Residual material from—
  - Shale and sandstone
    - Shale and sandstone
      - Light brown soil
        - Light brown subsoil
          - Bent
      - Red soil
        - Red subsoil
          - Albany
    - Shale
      - Light gray to grayish brown soil
        - Gray subsoil
          - Substratum shale
            - Chipeta
    - Sandstone
      - Pinkish red to reddish gray soil
        - Pinkish red to reddish gray subsoil
          - Shavano
- Alluvial fan and valley filling material
  - Shale sandstone and basaltic
    - Dark brown to black soil
      - Mottled gray yellow and drab subsoil
        - Substratum gravel
          - Drainage poorly established
            - Cedaredge
  - Shale sandstone and Mesa
    - Reddish gray to light brown soil
      - Gray to brown subsoil
        - Fruita
  - Granitic volcanic sandstone and shale
    - Brown to black soil
      - Gray to yellow subsoil
        - Bridger
  - Volcanic
    - Dark brown to black soil
      - Gray to brown subsoil
        - Substratum gravel
          - Drainage poorly established
            - Alamosa
    - Reddish brown soil
      - Gray to brown subsoil
        - Substratum porous, gravel
          - San Luis
- Lake-laid material
  - Basaltic
    - Light brown to brown soil
      - Grayish brown to brown subsoil
        - Manhattan
- River Flood Plain material
  - Granitic
    - Dark gray to brown soil
      - Gray to brown subsoil
        - Substratum gravel
          - Grand
  - Volcanic, metamorphic and sandstone
    - Gray to black soil
      - Gray to drab subsoil
        - Substratum gravel
          - Gallatin
        - Calcareous
          - Bozeman
    - Pinkish gray to light red soil
      - Gray to reddish gray subsoil
        - Deeper subsoil calcareous
          - Substratum gravel
            - Mesa
  - Metamorphic sandstone and shale
    - Light brown soil
      - Gray subsoil
        - Laramie
  - Shale and sandstone
    - Reddish gray to reddish brown soil
      - Brown subsoil
        - Calcareous
          - Substratum gravel
            - Uncompahgre
    - Gray to drab soil
      - Light gray to drab subsoil
        - Billings

SOILS OF THE NORTHWESTERN INTERMOUNTAIN REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

The northwestern intermountain region as defined in this report includes that portion of the Northwestern States lying within the inclosure bounded by the Pacific Coast region on the west, the Rocky Mountain region on the north and east, and the Great Basin region on the south.

In Washington, the region covers the whole southwestern portion of the State and embraces nearly one-half its area. In Oregon, it includes the northeastern and eastern parts with an arm extending into the south-central part and northern California. It also covers nearly the entire southern part of Idaho and less extensive areas in the western part of that State, northeastern Nevada, and northwestern Utah.

Its northern boundary in Washington is formed by the Okanogan Highlands and the Colville Mountains, extending eastward through this State to the lower foothills and outlying ridges of the Coeur d'Alene and Clearwater Mountains of Idaho.

In northeastern Oregon it extends to the Grand Canyon of the Snake River. In southern Idaho its northern boundary is formed by the lower mountains and foothills and it extends eastward to the Port Neuf, Blackfoot, Snake River and contiguous ranges, all of which are embraced within the Rocky Mountain region. To the south it is separated from the Great Basin province by usually inconspicuous and often arbitrarily located boundaries marking the Snake and Columbia River watersheds from that of the Interior Basin. Its western boundary in Oregon and Washington is formed by the eastern slope of the Cascade Range extending north and south and merging into the Sierra Nevada in the vicinity of Lassens Peak in northern California. This western boundary is conspicuous, except in southern Oregon and northern California, where the Lassen Peak volcanic ridge and adjacent region upon the north included within the northwestern intermountain province, merges with the Sierra Nevada, Cascade, and Klamath Mountains.

The region falls into three topographic subdivisions which may be designated as the Plateau Plains, the Central Upland and Mountain, and the Klamath-Lassen Peak districts.

The Plateau Plains is divided by the Blue Mountains and adjacent ranges into the Columbia River and Snake River plains. The Columbia River plains cover the greater part of the province in eastern and central Washington and north-central Oregon. The Snake River Plains embrace the larger part of the province in eastern Oregon and in southern Idaho. The altitude of these two plains in their various subdivisions covers a range of more than 4,000 feet. The Columbia River plains lie mainly at an elevation of 1,000 to 2,000 feet, while the Snake River plains vary in elevation from an average of approximately 3,000 feet in the western part to 5,000 or 6,000 feet in the eastern part of the province.

The Plateau Plains have a flat to undulating topography, the surface being arid and treeless, except for a heavy growth of sagebrush where not too rocky. Streams are of infrequent occurrence, flowing through deep, flat valleys with steep rocky walls. Rocky hills or low broad ridges are occasionally encountered, and in places recent volcanic cinder cones or outcrops of effusive lava sheets which underlie the plain in places to a depth of several thousand feet.

The central upland portion of the region embraces the Blue Mountains and the Powder River, Strawberry, Burnt River, and Cedar ranges in eastern and northeastern Oregon and southeastern Washington, and the elevated, dissected mountain and table lands extending across central Oregon from the Cascade Range. Allied with this district and included within the northwestern inter-

mountain region are the outlying ranges, foothills, and low ridges of the Cascades in central and south-central Washington and Oregon and the marginal, rugged, mountainous areas lying adjacent to the Snake River plains in southern Idaho.

The more elevated of the marginal mountain districts in southeastern Idaho reach an elevation of 7,000 to 9,000 feet or more. In Washington and Oregon the Blue Mountains and other of the higher ranges reach an altitude of 5,000 to 7,000 feet. In the latter districts and in north-central Oregon and along the eastern slope of the Cascades in Oregon and Washington, a heavy forest growth is found upon the higher ranges. Except in the westernmost part the lower lying areas and the ridges of the plains are usually rocky and barren. The higher mountains are deeply eroded, while many of the lower desert ridges and masses of later effusive rock show like weathering.

The southwestern extremity of the region embraced within the Klamath-Lassen Peak district consists of desert plains of filled valleys, broken by rocky ridges, volcanic cones and plains, elevated basaltic plateaus, and occasional broad, shallow lake basins. These lake basins often contain extensive areas of marsh or barren salt-incrusted plains. The elevated portions of the district are usually barren of forest cover. Many of the lake basins have no outlet and receive the drainage of the surrounding mountain slopes. They are thus much like the Great Basin region in topography, soil, and agricultural conditions. The boundary between the Klamath-Lassen Peak district and the Pacific Coast region upon the west is likewise obscure. Some of the drainage of the former at times of heavy precipitation reaches the Pacific Ocean.

The rocks of the northwestern intermountain region are predominantly effusive and mainly of basic or basaltic character. In the plains districts they are made up of sheets which lie nearly or quite horizontal, and have been built up by successive flows of highly fluid rock probably emanating from fissures or vents now obliterated. Fragmental ejected material is of widespread occurrence in the vicinity of the cinder cones and craters of recent origin. Andesitic and rhyolitic rocks are represented in certain portions of the region, particularly in the fragmental ejected material included within or overlying superficially the lava flows or other material of the plains in the districts adjacent to the Cascades, and in the vicinity of the Great Basin region. Small areas of sedimentary, metamorphic, and quartz-bearing granitic rocks occur in the Blue Mountains and in that part of southern Idaho included within the region.

The climate of the plains region is marked by a wet and a dry season with a limited rainfall. There is a wide range in seasonal temperatures, with hot summers and cold spells in winters. Clear days are numerous, the humidity is relatively low, and at certain seasons of the year the winds are excessive. The more elevated upland and mountain districts are subject to a moderately heavy rain and snow fall, are better adapted to grazing than the Plateau plains, and are frequently forested.

For purposes of classification, the soils of the region are arranged in several natural groups or provinces based upon mode of formation. While these provinces are generally distinct, the soils of any one province are subject to essential modifications owing to the operation of natural agencies and to various degrees of intergradation with the associated soils of other provinces.

The weathering in place of the exposed rocks has given rise to a superficial covering of soil material consisting of the rock product mixed with a varying content of organic matter accumulated through development and decay of plant growth. This group of soils constitutes the residual province.

Certain of the more northern or more elevated portions of the region were at the termination of the glacial period covered by superficial deposits of earth and rock fragments deposited directly from ice, or from débris-laden waters of streams derived from the melting ice. These deposits of glacial material have given rise to the soils of the Glacial province of the northwestern intermountain region.

High winds sweeping across unprotected portions of the region have become an important agency in the transportation and deposition of soil material. Extensive areas of wind-laid deposits have resulted, giving rise to a province of soils derived from wind-laid material. They are most extensively and typically developed in treeless areas and are usually of rolling to undulating topography. They cover extensive areas and embrace some of the more important agricultural soils of the region.

About the base of the mountains, ridges, and to some extent of the bluffs or slopes inclosing stream valleys extensive alluvial fan and sloping alluvial

plain deposits have been formed. They are most extensive and numerous in the desert valleys of the Klamath-Lassen Peak and other districts adjacent to the Great Basin region, where they consist predominantly of deposits laid down by intermittent streams. In these arid desert valleys such deposits are utilized for agriculture only under irrigation, which is often impracticable. Where encountered by the soil survey the soils of the Alluvial Fan province occur under pronounced arid conditions and are more favorably situated for irrigation. They are quite extensively utilized for irrigated and to some extent for dry-farmed crops.

Certain portions of the valleys and plains are covered by extensive deposits of sediments laid down in the waters of lakes during an earlier period. The more extensive consist of alluvial material washed from adjacent slopes and in many cases with included volcanic ash material deposited directly in the waters of the lakes by wind action or eroded from adjacent uplands and carried to the lakes by streams. Stratified deposits of the lake-laid sediments and volcanic ash are frequently interstratified with or buried beneath later lava sheets.

The older lake-laid material is frequently separated with difficulty from the areas of wind-laid and residual soils. It gives rise to important soil types within the region, which are, where developed, capable of producing a wide range of general farm and intensively cultivated crops. In the local lake basins of interior drainage. found throughout the desert plains, and particularly in the Klamath-Lassen Peak district, extensive deposits of lake-laid sediments of recent date are encountered. They are often marshy, alkaline, and capable of utilization for agricultural purposes only when drained. Some of them are subject to periodical submergence by waters of temporary lakes. While lake-laid material influences to some extent some of the soils encountered, none of the types derived from material of this character have been as yet recognized in the northwestern intermountain region by the soil survey.

In the elevated central upland and marginal mountain districts included within the Northwestern Intermountain region there are numerous perennial streams, often of considerable volume, some of which are fed by snow fields and glaciers of the mountain peaks. Some of these rise in the adjacent areas included within the Pacific Coast and the Rocky Mountain region. In the desert plain portion of the region perennial streams are infrequent. The areas are, however, traversed by the Columbia and the Snake Rivers, which are the principal streams of the region. Both rivers carry large volumes of water and have their headwaters in the Rocky Mountains outside the region. Some of the larger streams, rising in the mountainous areas, traverse the desert plains for a considerable distance, finally reaching the main streams of the Columbia and Snake River systems. Others of less stable flow lose part or all of their waters in their progress across the desert plains.

The larger streams of the region are subject to wide range in volume and during certain periods of the year to heavy floods, which favor the transportation and deposition of large quantities of alluvial sediments. Among many of the smaller streams, however. or of those of high gradient traversing the mountainous district, conditions are less favorable to sedimentation, and only limited areas of such deposits have been developed.

These sedimentary deposits of the flood plains and terraces of the stream valleys have given rise to a province of soils derived from the alluvial deposits of the River Flood plains. They occupy only a relatively small proportion of the area included within the region, but embrace a larger portion of the soils of the more highly developed agricultural districts.

The permanent development of agriculture in the Northwestern Intermountain region is being encouraged by the extension of irrigation. Owing to the fact that the more easily irrigated districts are developed first, these projects are progressively becoming more costly, though often extensive, and must be met by enhanced valuation of the soils in producing crops of high market value.

The following areas of the different soil provinces of the Northwestern Intermountain region have been surveyed:

Areas of different soil provinces in the Northwestern Intermountain region.

Soil province.	Acres.
Residual material	30,592
Glacial material	168,640
Wind-laid material	888,500
Alluvial fan and valley filling material	79,488
River flood plain material	901,632
Miscellaneous material	91,280
Total for region	2,160,132

RESIDUAL MATERIAL.

Residual soils occur extensively in the Northwestern Intermountain region, but are most typically and extensively encountered in the Upland and Mountain districts. Immense areas of the plains, even where covered but thinly by soil material, are practically devoid of residual soil material, owing to the fact that the product of weathering of the exposed rocks is swept away by winds as rapidly as formed. Where conditions favor the deposition of wind-laid material the residual material is buried beneath eolian deposits.

The soils of the Residual province are of minor agricultural importance, owing to the fact that they are often of shallow and rocky character and usually nonirrigable. They are extensively utilized for grazing, while some of the upland districts, with sufficient rainfall and of such character as to permit the use of farm machinery, are devoted to dry farming to grains. The more elevated and rugged mountain areas are adapted only to grazing or to forestry. The largest areas of residual soils are found outside the agricultural districts and have been included only to a limited extent within the areas surveyed. In so far as mapped they are represented by three series of soils. Although utilized to some extent for grains and fruit and capable of further development, none of these soils is of present agricultural importance. They are derived prevailingly from basic igneous rocks.

DESCRIPTION OF THE SOIL SERIES.

Cohasset series.—The members of the Cohasset series have light, reddish-brown soils and subsoils and are often of shallow depth. Water-worn gravel and bowlders are found throughout the soil section and outcrops of the underlying basaltic rock are of frequent occurrence.

The material is of residual origin from the underlying basaltic rock, modified in part by wind-blown or drifted material from other sources.

The types are generally treeless, occupying elevated situations, with a sloping to undulating topography. The surface is often broken and dissected by valley terraces and sometimes wind blown.

Area and distribution of the soil of the Cohasset series.

Soil name.	State or area.[1]	Acres.
Cohasset silty sandy loam	Washington, 6	4,416

[1] For key to number in this column see p. 733.

Moscow series.—These soils are prevailingly of a brown color and underlain to a depth of 2 feet by light brown subsoils, resting upon a bedrock substratum, which is encountered within the depth of 6 feet only in the shallower areas. The soils of the series are of residual origin and derived from granitic rocks, fragments of which are occasionally found in the soil profile. They occupy high rolling to rough hills and are usually well forested. The rough topog-

raphy renders extensive areas unsuited to agriculture. Under favorable conditions of climate they are adapted to grain crops. Fruits can be grown where the soil is sufficiently deep.

Area and distribution of the soil of the Moscow series.

Soil name.	State or area.[1]	Acres.
Moscow loam	Idaho, 3	6,208

[1] For key to number in this column see p. 733.

Underwood series.—The soils and subsoils of the Underwood series are of light brown to grayish brown color, and carry numerous small, soft pellets of weathered basaltic material or of mineral aggregates formed by cementing of the mineral particles by iron solutions. These are most numerous near the surface and range in size from coarse sand to one-half inch in diameter. Basaltic gravel and rounded bowlders are of frequent occurrence in both soil and subsoil. The series is of residual origin. Rock outcrop is frequent along the steeper slopes, the members occupying rolling to steep and hilly foothill districts and mountain slopes. The soils are well drained and support a scrubby growth of fir and hemlock. Where favorably located they can be utilized for agricultural purposes to some extent without irrigation, although this is generally necessary for effective development.

Area and distribution of the soil of the Underwood series.

Soil name.	State or area.[1]	Acres.
Underwood loam	Washington, 7	19,968

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Most of the area of residual soils of the Northwestern Intermountain region is of rough and broken topography and unsuited to agriculture The soils are therefore outside the principal agricultural districts and have not been encountered to any great extent during the progress of the soil survey in this region. From a standpoint of crop production under existing conditions they are not of any great importance.

In the areas surveyed they have been recognized under three soil series, each of which is as yet represented by only a single type. One of these is a silty sandy loam and the other two are of loam texture. They are not at present extensively utilized for agriculture and ordinarily require irrigation and other improvement before they can be profitably worked on any extensive scale. The topography is frequently rough and broken, but where capable of irrigation these soils give promise of development for fruit growing. The general farm crops are grown to a limited extent without irrigation.

The silty sandy loam type, recognized under the Cohasset series, occupies arid, treeless areas. It is not used for farming and is without prospects of immediate irrigation development. The deeper areas of favorable surface contour could, when irrigated, be used for apples and other tree fruits, alfalfa, grains, and forage crops. The type can be readily maintained in a good condition of tilth and seems best suited to fruit culture.

The loam members of the province occupy rolling to hilly and mountainous districts. They generally support considerable timber or forest growth and under favorable seasonable climatic conditions cereals, flax, hay, and forage crops are grown to some extent without irrigation. The soil is friable, requires only a moderate farming equipment after once cleared or prepared for irrigation, and where of good depth is retentive of moisture under cultivation. These types include rough and rocky areas of thin soil not adapted to agriculture. Apples, cherries, peaches, and other fruits can be grown under irrigation on

the deeper soils. They are not ordinarily well suited to general farming purposes except in small tracts, as the rough topography precludes the use of farm machinery.

SANDY LOAM GROUP.

SILTY SANDY LOAM PHASE.

Cohasset silty sandy loam.—The surface soil is a light reddish brown loam, about 10 inches deep, high in silt, coarse sand, and gravel, with some clay and medium sand. Angular rock fragments and rounded or subangular bowlders are found in the surface soil. Under field conditions this type approaches a loam with a heavy content of coarse sand. The subsoil is slightly redder than the soil and heavier in texture. It is generally shallow and underlain by fragments of basaltic rock at a depth of 20 to 30 inches, which may extend to a depth of 6 feet or more. The type is residual, occupying elevated, erosion valley terraces of sloping or undulating topography and often dissected by deeply eroded, narrow, rocky ravines. Rock outcrop is of frequent occurrence and the surface is somewhat wind blown. Where capable of irrigation it is adapted to fruit.

Area and distribution of the silty sandy loam.

Soil name.	State or area.[1]	Acres.
Cohasset silty sandy loam	Washington, 6	4,416

[1] For key to number in this column see p. 733.

LOAM GROUP.

Moscow loam.—The surface soil consists of a brown loam about 24 inches deep, underlain by a light-brown subsoil which rests upon a bedrock substratum encountered at a depth of 6 feet or more. There are numerous shallow areas throughout the type where the bedrock more closely approaches the surface. Rock fragments are occasionally found throughout the soil profile. The type is derived from crystalline rock and is of residual origin. It occupies areas elevated above the surrounding country and of rolling to rough and hilly topography. The type is usually timbered and much of the areas mapped is too rough to be used for agriculture. Under favorable conditions wheat, oats, and flax can be grown. The type is not well adapted to fruit crops.

Underwood loam.—The soil has an average depth of 18 inches and contains a variable amount of small weathered basaltic fragments or soft iron pellets. These are usually about one-fourth inch in diameter and are mixed with the soil and scattered over the surface They are soft and easily crushed between the fingers. The subsoil consists of a yellowish-brown loam or silt loam 3 feet or more in depth, becoming slightly heavier toward the lower portion of the soil section. The content of gravel and iron pellets decreases with depth, only a comparatively small amount of coarse material being found at 3 feet. Basaltic bedrock is not usually encountered near the surface. The type is of residual origin and derived from basaltic rocks. It occupies rolling to hilly uplands, with an elevation ranging from 1,000 to 3,000 feet. Limited areas of gently undulating topography and a few steep slopes are found in the vicinity of stream courses. The soil is somewhat deficient in organic matter. Under favorable conditions of moisture supply and cultivation, it is adapted to fruits and general farm crops.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Underwood loam	Washington, 7	19,968
Moscow loam	Idaho, 3	6,208
Total		26,176

[1] For key to numbers in this column see p. 733.

GLACIAL MATERIAL.

In so far as mapped the soils of glacial origin in the Northwestern Intermountain province are derived wholly from stream-laid or glacial-outwash deposits. They have been recognized only in areas of limited extent in east-central Washington, but they probably cover a much greater part of the region in northern Washington and Idaho than would appear from the limited areas surveyed.

The glacial streams giving rise to the deposits followed well defined but now extinct stream channels, and probably owed their origin to the obstruction of the valleys of Columbia River or of other streams by glacial ice.

Occasional glacial bowlders probably deposited from floating ice fragments are of rather widespread occurrence in the transported soils of certain areas surveyed in the region. They are generally found as extraneous matter of minor importance in the soil forming material.

The soils of the region as mapped are derived wholly or predominantly from glacial material and are limited to one type series, the Ephrata soils. They occupy terraced, treeless, desertlike plains. They are partially utilized for the production of grains and, where irrigated, to the production of fruits. Topographic and drainage conditions usually favor irrigation, and an extension of these facilities will do much to develop intensive agriculture on these soils.

DESCRIPTION OF THE SOIL SERIES.

Ephrata series.—These soils are of light grayish-brown to yellowish-brown color and carry variable amounts of water-worn gravels. They are often strewn with subangular to rounded bowlders and have been subject to some modification by wind action. The subsoils are porous but compact and consist largely of subangular or rounded gravel and bowlders, and often extend to great depth. The finer interstitial material is of light-gray color. The gravels and bowlders of the soil and subsoil are mainly basaltic, with some crystalline rocks. The members of the series occupy terraced desert plains of level to undulating or irregular surface and are devoid of timber. The immediate surface is sometimes slightly wind blown and the successive terraces are generally bounded by steep, rocky, and eroded slopes, occasionally traversed by broad channels of old glacial streams. The parent material of both soil and subsoil is derived from glacial outwash.

Area and distribution of the soils of the Ephrata series.

Soil name.	State or area.[1]	Acres.
Ephrata sandy loam	Washington 6	36,032
fine sandy loam	do	86,272
stony fine sandy loam	do	46,336
Total		168,640

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils of the glacial province in the Northwestern Intermountain region of glacial outwash origin are confined to a single soil series, which is represented by three soil types.

These three members have a sloping to undulating topography. The surface is often wind blown and dissected by deeply eroded, extinct stream valleys. The soils are somewhat compact and friable, with a substratum of porous gravel. Bowlders and cobbles on the surface often interfere with cultivation unless removed. The soils occupy treeless, desert plains, are excessively drained, and subject to drought where not irrigated. Large areas are unutilized or are devoted to grazing. Grains are grown quite extensively without irrigation, but low yields are frequent owing to deficient rainfall.

The surface contour and drainage conditions are generally favorable to the distribution of irrigation waters. Local irrigated districts have proved particu-

larly successful in the production of apples, peaches, and other tree fruits, grapes, melons, and garden vegetables. With further development in this direction the soils of the glacial province can be used for the general farm crops, fruits, and truck crops.

The sandy loam and stony fine sandy loam should prove well suited to early stone fruits, melons, and truck. The fine sandy loam will probably prove the most suitable soil of the province for general farm crops. Alfalfa, forage crops, and grains can probably be successfully grown under irrigation, but the soils are not so well suited to grass crops or to a heavy type of general farming. When devoted to intensively cultivated products under irrigation they can be economically utilized in small tracts, and with favorable market and transportation facilities will become capable of supporting thickly settled rural communities.

SANDY LOAM GROUP.

Ephrata sandy loam.—The soil is a compact, friable sandy loam, of rather coarse texture, from 16 to 20 inches deep, carrying some fine material but little of the medium grades. The coarse texture is particularly noticeable in the surface few inches, approximately a coarse sand or fine gravel. The subsoil consists largely of fine gravel with finer interstitial material. The type is derived from glacial outwash material of lacustrine origin. The surface is broken by low, broad ridges or mounds of irregular occurrence. Drainage is well established and the type droughty. It is generally well adapted to irrigation.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Ephrata sandy loam	Washington 6	36,032

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

Ephrata fine sandy loam.—The surface soil is friable and compact, ranging in depth from 12 to 24 inches or more. It carries a rather high proportion of very fine sand, with varying quantities of gravel and a few small bowlders and cobbles scattered over the surface and in the soil. The subsoil consists of coarse, well rounded material sometimes reaching the surface in shallower areas, and in the Quincy area, Washington, extending to a depth of 100 feet or more. The type consists of glacial outwash material derived from basaltic rocks. The gravel and bowlders are not sufficiently extensive to affect cultivation. Drainage is excessive and the type subject to drought during seasons of deficient rainfall. Where not too shallow it is adapted to fruits under irrigation.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Ephrata fine sandy loam	Washington 6	86,272

[1] For key to number in this column see p. 733.

STONY FINE SANDY LOAM PHASE.

Ephrata stony fine sandy loam.—This type is a fine sandy loam of rather silty texture and carrying a large amount of gravel and small bowlders. Strata of gravel and bowlders are encountered at a depth of 6 to 14 inches and in places reach the surface. The type is usually characterized by low undulations or mounds with intervening depressions. The type is derived from glacial outwash material of basaltic origin. Drainage is good, but the soil is deficient in moisture-retaining capacity and not well adapted to farming without irrigation. Where this is possible it is well adapted to tree fruits. Ordinarily it is necessary to remove a large amount of stone from the surface before the land can be utilized for agricultural purposes.

Area and distribution of the stony fine sandy loam.

Soil name.	State or area.[1]	Acres.
Ephrata stony fine sandy loam	Washington 6	46,336

[1] For key to number in this column see p. 733.

WIND-LAID MATERIAL.

The deposits of wind-laid material are most extensively and typically developed in the Columbia River and Snake River plains and in portions of the Klamath-Lassen Peak district.

The surface is usually treeless and protected only by a scattering growth of desert shrubs from the high winds that prevail during certain periods of the year. These winds transport large quantities of fine material during the passage of dust storms. In protected localities the deposition may be augmented by further accretions at recurring intervals. The area thus affected is largely determined by the wind velocity and the natural protection offered by land topography and vegetation. The heavier mineral particles of soil are rolled along the surface until lodged in some protected locality.

The wind-laid soils of the region vary from a few inches to several feet in depth. They are derived predominantly from basaltic rock, although some of the types include conspicuous fragments of quartz, feldspar, or other material derived from quartz-bearing minerals. Some of the deposits are predominantly of fine texture and of deep, loess-like character. In other districts coarser sands prevail, the material having been derived from less distant sources. Most of the lighter textured soils of the region where not of wind-laid origin have been modified to some extent by eolian agencies.

The soils of the Wind-laid province in the Northwestern Intermountain region, in so far as encountered in the soil survey, are represented by the Walla Walla, Winchester, and Quincy series. The topography is comparatively flat to undulating or rolling, and the surface in some of the soil series is subject to the occurrence of wind-blown mounds, ridges, or dunes.

Where favored by conditions of ample rainfall the soils of finer texture, such as occur in the Palouse and adjacent districts in eastern Washington, western Idaho, and northeastern Oregon, are retentive of moisture and are extensively devoted to dry farming to grains with excellent results. The arid districts, when irrigated, are adapted to the production of alfalfa, grains, sugar beets, hops, truck and fruit crops, according to soil texture and structure, local climatic conditions, and other modifying conditions. Owing, however, to limited sources of water for irrigation or to the deeply intrenched position of the main streams extensive irrigation of the upland wind-laid soils is often impossible or can only be secured by extensive and costly engineering operations.

DESCRIPTION OF THE SOIL SERIES.

Quincy series.—The soils of the Quincy series are grayish brown and usually of loose, porous structure. The subsoils are similar in color and texture to the soil, but slightly more compact. Large amounts of quartz fragments and dark-colored basaltic rock particles, as well as noticeable amounts of micaceous material, appear in both soil and subsoil. The subsoils are underlain by a substratum of calcareous material, resembling a hard limestone resting upon rounded, basaltic cobbles, gravels, and bowlders underlain in turn by basaltic bedrock. The series is of eolian origin, occupying treeless, undulating plains. The surface is often strewn with chips or fragments of the underlying calcareous material, and varies in configuration from moderately smooth to wind drifted. Crops are apt to suffer somewhat from movement of the surface material by winds. The members of the series cover extensive areas and often grade imperceptibly into each other and into surrounding soils of other series.

Area and distribution of the soils of the Quincy series.

Soil name.	State or area.[1]	Acres.
Quincy sand	Oregon 2; Idaho 4	42,944
fine sand	Washington 6, 9	106,676
very fine sand	Washington 6	56,512
sandy loam	Idaho 4	29,760
fine sandy loam	Washington 6, 9	149,312
silty fine sandy loam	Washington 6	62,976
silt loam	do	9,472
Total		457,652

[1] For key to numbers in this column see p. 733.

Walla Walla series.—The Walla Walla series consists of sticky, brown to dark-brown soils about 3 feet deep, underlain by yellow silt loam subsoils which are often sticky and plastic. They are derived from wind-laid deposits of basaltic origin. The series occupies high, rolling hills, often of steep slope. The soils occur under subhumid climatic conditions and are usually treeless and well drained. Wheat and barley are extensively grown with good results. Oats are also grown extensively in certain districts, and flax, vegetables, apples, and cherries are produced to a limited extent.

Area and distribution of the soil of the Walla Walla series.

Soil name.	State or area.[1]	Acres.
Walla Walla silt loam	Idaho 3; Washington 8	287,936

[1] For key to numbers in this column see p. 733.

Winchester series.—The soils and subsoils of the Winchester series are dark gray to nearly black and consist mainly of dark-colored angular fragments of basalt, though a noticeable proportion of quartz also occurs. Basaltic pebbles are sometimes found in the soil section and upon the surface over wind-swept areas. As mapped in the Quincy area, Washington, the material is underlain at great depths by rounded basaltic glacial outwash bowlders and gravels. The series is of eolian origin and occupies undulating, treeless plains or plateaus. The types are extensive in area, grading imperceptibly into the surrounding soils. The surface is frequently wind drifted or marked by dunes. The native vegetation is typical of the region, and the soils are but poorly adapted to agriculture without irrigation

Area and distribution of the soils of the Winchester series.

Soil name.	State or area.[1]	Acres.
Winchester sand	Idaho 1; Washington 6	50,752
coarse sand	Washington 6	87,232
fine sand	do	4,928
Total		142,912

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

The eolian or wind-laid soils of the sand group in the Northwestern Intermountain region cover extensive areas in the treeless desert, wind-swept plains of Oregon, Washington, and Idaho. They have been recognized under two soil series, differing essentially in the color of the soil and subsoil material and in the character of rock from which they are derived.

The surface is usually undulating and wind blown, and where cleared of native vegetation or broken by cultivation crops often suffer from the soil drifting where not protected by windbreaks. Surface drainage is generally well established and underdrainage excessive. The soil material is loose and incoherent and surface waters are to a large extent absorbed by the soil. The water-holding capacity is, however, low, and frequent and copious irrigation ordinarily a necessity.

Irrigation is not at present extensively practiced, and most of the soil areas are unutilized or devoted to dry-farmed grains. In favorable seasons fair results are obtained, but the soils are subject to drought and the average yields are light. The soil is easily cultivated and requires but a light farming equipment, though considerable labor in leveling and preparing the land for irrigation is frequently necessary. Owing to the loose, porous character of the surface material upon drying, which is usually aggravated by movement of the soil grains by wind, a superficial mulch formed through natural agencies frequently helps to protect it from loss of subsoil moisture by evaporation and renders the soils more retentive of moisture than is usually the case with soils of sandy texture and porous structure.

Grains, alfalfa, and potatoes are the principal products on the irrigated lands. The sands of this province are, however, better adapted to early stone fruits, small fruits, melons, and early truck crops than to general farm crops. This is particularly true where transportation and market conditions favor intensive trucking and where sufficient protection from winds is afforded. In exposed areas, where intertilled crops suffer from winds, the soils are better utilized for alfalfa or some other permanent cover crop.

The soils are deficient in organic matter, and the systematic use of green manures or of well-decomposed stable manure is advisable. They should respond quickly to fertilization, but more frequent applications are necessary than is the case with the soils of heavier texture. Mineral fertilizers are rarely necessary. The sandy soils are not adapted to the production of hay crops, with the possible exception of alfalfa, while the general farm crops do better on the heavier soils. Under irrigation, however, good yields can be secured with more regularity than is possible under natural conditions.

Quincy sand.—The soil is yellowish brown to reddish brown in color and of loose, porous structure. The subsoil is somewhat lighter in color than the soil, but similar in texture and structure and occasionally underlain by a stratum of soft, cemented sandy material. The soil material is of wind-blown origin, derived mainly from basaltic rocks. The topography is slightly undulating, and the surface is wind blown. The type occupies comparatively level desert, treeless, valley plains and is well drained. Under cultivation it drifts badly when not protected by windbreaks or by surface vegetation, but where irrigated and protected from winds it produces fair crops of grain and alfalfa, being well adapted to the latter crop. Potatoes are also grown to a limited extent with good success.

Winchester sand.—The Winchester sand contains about equal amounts of coarse, medium, and fine sand, extending to a depth of 6 feet or more. Below the immediate surface the material is slightly compact, continuing to a depth of nearly 2 feet, where the structure becomes somewhat porous. The topography is undulating with low, wind-blown mounds and ridges, with intervening level basins or flats. When cleared of native desert vegetation the surface is subject to serious wind drifting. The type is well drained and requires leveling for irrigation.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Winchester sand	Idaho 1, Washington 6	50,752
Quincy sand	Oregon 2, Idaho 4	42,944
Total		93,696

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

The coarse sand phase of the sand group of soils is represented by a single member. In topography, drainage, and adaptability to irrigation and susceptibility to wind drifting it resembles the normal sand member of the same series. The soil material is somewhat coarser, making the structure more porous and leachy and more sensitive to drought. It is not extensively utilized at present and is inferior to the normal members of the sand group in general agricultural value. It is not suited to the production of general farm crops and is limited to a more narrow range of possibilities in utilization than the sand of the same series under which the coarse sand occurs. With copious and frequent irrigation, repeated cultivation, and systematic use of green manure, it can be used for melons and early truck crops. Rather light yields are to be anticipated, but the products should be available for early market. Alfalfa might be grown for green manuring purposes and would probably prove of some value for pasture or hay, and would afford protection to the surface in wind-swept localities.

Winchester coarse sand.—The Winchester coarse sand is generally of uniform texture and of open, porous structure to a depth of 6 feet or more. The soil section includes small amounts of feldspar and mica. The surface is marked by low, wind-blown ridges and mounds, with irregular, nearly flat, intervening areas. Drainage is well established and the type free from injurious amounts of alkali salts. Crops are subject to injury at times from movement of the surface material by the winds. Leveling is generally necessary for irrigation.

Area and distribution of the coarse sand.

Soil name.	State or area.[1]	Acres.
Winchester coarse sand	Washington 6	87,232

[1] For key to number in this column see p. 733.

FINE SAND GROUP.

The soils of the fine sand group occur under two principal series of wind-laid soils of the Northwestern Intermountain region. They have been encountered less frequently than the sands of the province occurring under the same series.

Like the soils of the sand group they occupy comparatively level, treeless, desert plains, often of hummocky, wind-blown surface, and are of porous, incoherent structure. Surface drainage is usually well established except in local included flats or basinlike depressions, and underdrainage is generally excessive. The soils and subsoils are usually deep, except in a shallow phase of the Quincy fine sand.

The soil is easily cultivated and requires but light farming equipment. Considerable labor in leveling is generally necessary in preparing the land for irrigation. Crops in exposed areas are sometimes subject to injury from movement of soil particles by winds where not protected by windbreaks or cover crops. The production of dry-farmed grains is the principal use of these soils at present, a large portion of the areas being allowed to stand idle.

Under intensive cultivation the fine sands are superior to the sands in moisture-retaining capacity. They are suited to products of the same general character, including in particular stone fruits, small fruits, melons, and early truck crops. They are probably better adapted to the production of alfalfa, forage crops, and grains than the sands, and where subject to wind drifting can probably best be utilized for alfalfa. They are deficient in humus, and the application of organic manures, preferably of green crops, should be systematically and frequently practiced.

Quincy fine sand.—The soil is of loose, incoherent structure, with a noticeable content of coarse sand and calcareous fragments or chips in the shallower areas. The subsoil is similar to the soil and sometimes carries noticeable amounts of coarse sand particles. The surface is usually undulating and often drifted into dunelike ridges, or mounds. The type is well drained. The underlying calcareous material and rock are found sometimes at a depth of 5 to 10 feet or less, but usually occur at greater depths. Considering the loose, porous texture and

structure, the type is fairly retentive of moisture and produces good crops of grain by dry farming in favorable seasons. It requires surface leveling for irrigation. With irrigation alfalfa, tree and small fruits, and early truck crops can be grown.

Winchester fine sand.—This type is of open, porous structure and generally extends to a depth of 6 feet or more with but little variation in color or texture, save that a noticeable amount of medium to coarse sand is generally evident in the surface material. The surface is marked by low, wind-blown ridges and mounds inclosing intervening flat depressions. Drainage is excessive and the type subject to drought when dry farmed. When leveled and irrigated it is well adapted to alfalfa and other crops except over the shallower areas.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Quincy fine sand	Washington 6, 9	106,676
Winchester fine sand	Washington 6	4,928
Total		111,604

[1] For key to numbers in this column see p. 733.

VERY FINE SAND PHASE.

Very fine sand has been encountered under one soil series in this province.

The topography is subject to a wider range than is the case with the normal fine sands of the province, the very fine sand occupying rolling to hilly areas as well as the level or gently undulating plains. The hilly areas are not generally adapted to irrigation on account of irregular surface contour and owing to difficulty in obtaining local water supply or in conveying water to the elevated areas from distant sources. The topography is, however, rarely of so rough a character as to preclude the use of farm machinery, and the soil is devoted quite extensively to dry-farmed grain production.

The soil material is finer and more loamy than the fine sand under normal conditions, and superior in moisture-retaining capacity. The structure is loose and friable, though more coherent than the members of the fine sand and sand groups. It is somewhat subject to wind drifting, and irrigable areas usually require leveling in preparing the land for cultivation. Only a light farming equipment is required in cultivation, but a heavier type of farming implements and draft stock is necessary in preparing the land for irrigation or in the cultivation of the more elevated, hilly areas.

The very fine sand, so far as encountered, where incapable of irrigation can not well be utilized for the production of other than shallow-rooted grains or drought-resistant forage crops. Where irrigated, exposed areas not underlain by impervious substratum at shallow depths are best utilized for the production of alfalfa. Watermelons, cantaloupes, and early truck crops and tree and small fruits can be grown under favorable conditions of irrigation, depth of soil, and market facilities. The phase is somewhat better adapted to general farming than the lighter textured soils of the province, and where irrigated is closely allied in crop adaptation with the fine sandy loams of the same series.

Quincy very fine sand.—The surface soil has an average depth of 12 to 15 inches. The subsoil consists of a fine sandy loam grading at times into a fine or very fine sand with a noticeable content of silt over the deeper portions of the subsoil. Small wind-blown mounds and ridges are a common surface feature. The type as mapped in the Quincy area, Washington, includes a hilly phase of rolling, elevated topography, in which the underlying, calcareous material sometimes occurs at relatively shallow depths. Drainage is good and the type generally free from alkali. Dry farming in seasons of favorable rainfall gives fairly good results. Irrigated crops can be grown, but the land generally requires leveling before water can be applied.

Area and distribution of the very fine sand.

Soil name.	State or area.[1]	Acres.
Quincy very fine sand	Washington 6	56,512

[1] For key to number in this column see p. 733.

Sandy Loam Group.

The sandy loam group of the Wind-laid province in this region, in so far as recognized by the soil surveys, is limited to the sandy loam member of the Quincy series. This has been encountered in only one area surveyed where it is of extensive occurrence.

The topography is comparatively level and surface drainage is frequently poorly developed. Underdrainage is excellent and in many places excessive. The surface contour is irregular owing to drifting, and leveling is ordinarily necessary in preparing land for irrigation.

This type occurs under arid conditions and supports only a natural desert growth. The structure is porous and it is deficient in moisture-retaining capacity. Irrigation is ordinarily necessary for any form of successful agriculture.

Grains, potatoes, and alfalfa are the principal crops grown under irrigation. In crop adaptation it does not depart widely from the fine sand and very fine sand of the province. It is best adapted to the production of melons, truck crops, and small fruits, and to a light type of general farming. Tree fruits could probably be grown under favorable climatic conditions. In exposed localities the type is best utilized for the production of alfalfa.

Cultivation is easy and only a light farming equipment is required.

Quincy sandy loam.—The surface soil is a yellowish-brown, rather coarse textured, loose, porous sandy loam. The subsoil in the upper portion is similar to the soil, grading into a dark-colored, coarse sandy loam, in the lower part of the soil section. The type occupies comparatively level to gently undulating treeless plains, the surface being uneven and wind blown and requiring leveling for irrigation purposes. Drainage is poorly established but surface waters are readily removed owing to the porous subsoil. The type is of wind-laid origin, though a portion of the material is probably stream deposited, modified somewhat by wind action. The soil and subsoil material are derived from crystal line and basaltic rocks, the dark colored upper subsoil being mainly of basaltic origin. Small grains, alfalfa, and potatoes constitute the main products of the type. It is best adapted to alfalfa, potatoes, and early truck crops.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Quincy sandy loam	Idaho 4	29,760

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The soils of the fine sandy loam group are represented by a single member occurring under the Quincy series.

In the Yakima area, Washington, the type carries a large quantity of stones and bowlders and is of minor agricultural value, with only local areas of arable land. In the Quincy area, Washington, a calcareous hardpan layer often occurs at shallow depth, which will, under irrigation, limit underdrainage and the suitability of the soil to the culture of alfalfa, tree fruits, or other deep-rooted crops.

The soil material is porous and frequently drifted by winds. More or less leveling is generally required in preparing the land for irrigation. Crops upon exposed areas sometimes suffer from the drifting of the soil particles by winds although this feature is less pronounced than on the soils of lighter texture.

The soil is easily cultivated and requires but a light farming equipment. It is rather deficient in moisture-retaining capacity and is not economically utilized for dry farmed crops where capable of irrigation. It is at present devoted mainly to the culture of grass without irrigation, but average yields are light owing to deficient rainfall. Where favored by topography, irrigated and free from stones it is well adapted to the production of truck crops, apples, and stone fruits, grapes, and small fruits and to general farming, including alfalfa and grain production.

Quincy fine sandy loam.—The soil is from 12 to 15 inches deep. The subsoil is slightly lighter than the surface soil, rather compact, and rests upon the calcareous substratum characteristic of the series and typically encountered at a depth of 5 feet or more, but which in this type frequently lies nearer the surface. The topography is level to undulating with numerous low wind-blown mounds and ridges. The type consists of wind-laid deposits derived from basaltic and crystalline rocks. It is well adapted to irrigated crops, but deficient in moisture-retaining capacity when dry farmed.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Quincy fine sandy loam	Washington 6, 9	149,312

[1] For key to numbers in this column see p. 733.

SILTY FINE SANDY LOAM PHASE.

Silty fine sandy loam occurs only under the Quincy series. In texture it differs from the normal fine sandy loam of the same series in having a higher proportion of soil particles of the finer grades and consisting principally of silty material.

It occupies undulating to rolling, treeless desert plains, which are, however, more frequently dissected or broken than is the case where occupied by the lighter textured soils of the same series. The surface material is more loamy in character, is quite sticky when wet, less subject to wind drifting, and possesses a tendency to puddle if cultivated when wet and to bake upon exposure. The soil requires a heavier farming equipment than those of the normal fine sandy loam or lighter groups, but is friable under cultivation, is readily maintained in a favorable condition of tilth, and is more retentive of moisture than the wind-blown soils of lighter texture in the Northwestern Intermountain Province.

Drainage is not excessively developed, as is the case with the lighter soils of the Quincy series, and under irrigation artificial drainage will in some localities be necessary.

The silty fine sandy loam is closely allied with the silt loams of the province in adaptation to agriculture. Under irrigation the general farm crops, particularly alfalfa, grains, and forage crops, can be grown readily. Under favorable conditions of drainage, climate, and market facilities the type is well suited to the production of fruits and truck crops. It is less suitable for early fruits and truck than the fine sandy loam and lighter soils of the province.

Quincy silty fine sandy loam.—The soil, to a depth of 10 to 24 inches, is a light yellowish-brown, friable and rather compact fine sandy loam, carrying a relatively high percentage of silt. It is inclined to crack and clod unless plowed under proper moisture conditions. The subsoil is a compact, grayish silty fine sandy loam or silt loam. The topography is level to rolling and the surface often dissected by deep, narrow ravines or erosion channels. Shallow drifts of fine sands sometimes occur. The type is fairly retentive of moisture under cultivation and adapted to dry-farmed grains in favorable seasons. Under irrigation it is suitable for the production of fruits, vegetables, and alfalfa, but in some places would require artificial drainage.

Area and distribution of the silty fine sandy loam.

Soil name.	State or area.[1]	Acres.
Quincy silty fine sandy loam	Washington 6	62,976

[1] For key to number in this column see p. 733.

Silt Loam Group.

Soils of the silt loam group occur under two series widely distributed over the Northwestern Intermountain region. They have been encountered in several areas surveyed.

These two members of the group vary widely in topography and drainage, one occurring in areas of treeless, desert plains and occupying undulating depressions of rather poorly developed drainage while the other occupies rolling, hilly areas over which drainage is excessively developed.

The soils are usually of good depth and underlain by subsoils of high water-holding capacity. They are usually sticky when wet and where poorly drained puddle readily and bake and crack upon subsequent exposure. Where well drained they are friable under cultivation and readily assume a mellow structural condition. They require a heavier farming equipment than the lighter soils of the province and are better adapted to general farming purposes. The rolling and hilly areas not susceptible of irrigation are extensively utilized for the production of wheat and barley. Where irrigated, grains, alfalfa, vegetables, tree and small fruits are grown. Alfalfa can usually be grown in the irrigated districts. The soils of lighter texture are better suited to the commercial production of early fruits and truck crops, but apples, late cherries, and other stone fruits, small fruits, and staple vegetables for general market, canning, or preserving purposes can be profitably grown upon the silt loams under favorable conditions.

Quincy silt loam.—The soil consists of about 10 inches of light yellowish-brown to light-gray silt loam, carrying large amounts of very fine sand and but little clay. It is rather compact and tends to bake and crack upon exposure. The subsoil is a light grayish-brown silt loam, but is ordinarily slightly lighter in color than the soil. It occupies broad, shallow depressions of gently sloping or gently undulating topography, wind drifting being unusual. Where cultivated the soil is retentive of moisture and under irrigation is adapted to grains, vegetables, alfalfa, and fruits. Much of the type requires artificial drainage if extensively irrigated.

Walla Walla silt loam.—This type consists of a very sticky brown to black silt loam or loam about 3 feet deep, underlain by a silt loam. The type is of wind-blown origin, derived mainly from basaltic material. It occupies very high, steep hills. Wheat and barley and other grains do well without irrigation, giving large yields. Under irrigation the type is adapted to vegetables, apples, cherries, and other fruits.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Walla Walla silt loam	Idaho 3; Washington 6, 8	287,936
Quincy silt loam	Washington 6	9,472
Total		297,408

[1] For key to numbers in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The soils derived from the alluvial fan and valley filling material have been encountered only in limited areas within the region. Some of these are agriculturally important, while others represent inextensive local soil bodies which are comparatively insignificant.

In many localities the soil consists of typical alluvial fan deposits distributed by streams, often of intermittent character, emerging from mountain canyons or ravines in the adjacent uplands. In others the material occupies sloping to nearly level alluvial foot slopes, formed mainly through the deposition of material transported from higher levels by surface sheet wash or intermittent streams.

In so far as mapped the soils are confined to three soil series, each of which is represented by only a few members.

The material from which the soils is derived embraces basaltic, granitic, or related quartz bearing crystalline and to some extent sedimentary rocks. Some of the deposits include an admixture of material from all these sources and are represented by the Hutchinson series, which has been encountered at the foot of the Blue Mountains in northeastern Oregon. Others are made up of an admixture of material from basic and acid igneous rocks, the material derived from sedimentary rocks being absent. The material of this character is represented in the soils of the Baker series occurring at the foot of the Blue Mountains and also in the Klamath-Lassen Peak district. Local areas of deposits assigned to this province derived from basaltic material and occupying local poorly drained, depressed areas in the region of the Columbia River plains are included under the Naylor series.

In agricultural importance the soils of the province are subject to wide variation, depending upon local conditions of rainfall, drainage, and facilities for irrigation.

DESCRIPTION OF THE SOIL SERIES.

Baker series.—The soils are light gray to yellowish brown or brown, with yellow or yellowish-brown subsoils frequently similar to the surface soil in color, texture, and structure, but becoming heavier in texture with depth. The series is derived from basaltic and crystalline rocks and consists of alluvial stream outwash or fan deposits. The soils are sometimes poorly drained under irrigation and subject to the accumulation of alkali salts. Under favorable conditions of climate, rainfall, and drainage, alfalfa, grains, potatoes, and other vegetables and fruits can be grown.

Area and distribution of the soils of the Baker series.

Soil name.	State or area.[1]	Acres.
Baker fine sandy loam	Oregon 2; California 7	17,280
loam	Oregon 1	10,816
Total		28,096

[1] For key to numbers in this column see p. 733.

Hutchinson series.—The soils are predominantly brown to dark brown or black, underlain by gray, grayish-brown, or yellowish subsoils. Variations in texture occur throughout the soil section, the upper subsoil often being heavier than the soil and the lower subsoil and sometimes being cemented into a calcium carbonate hardpan. The soils of the series consist of alluvial fan and alluvial foot-slope deposits, with an admixture in places of true colluvial material. They are derived prevailingly from quartz-bearing granitic rocks, with an admixture in places of effusive or sedimentary rocks. They occupy sloping to nearly level situations adjacent to mountains and foothills and are sometimes broken by eroded stream valleys. Drainage is ordinarily well established and the soils generally free from injurious accumulations of alkali salts. Considerable areas are unutilized except for grazing purposes, owing to the lack of irrigation facilities. Where water for such purposes is available the soils are adapted to grains, hay crops, and tree fruits, depending upon the texture and local conditions.

Area and distribution of the soils of the Hutchinson series.

Soil name.	State or area.[1]	Acres.
Hutchinson loam	Oregon 1	30,784
gravelly loam	do	17,216
Total		48,000

[1] For key to number in this column see p. 733.

Naylor series.—The soils and subsoils are gray to drab when dry, becoming darker when wet, and underlain by a stratum of rounded basaltic gravel and bowlders or by basaltic bedrock, usually at less than 6 feet. They occupy treeless depressions in the upland desert plains or plateaus or the channels of old glacial streams. The material is apparently of basaltic origin and consists of old alluvial glacial outwash deposits or the product of erosion from soils of the Ephrata series. In some places the soil has been modified by wind-laid material, and in the vicinity of steep bluffs by accretions of colluvial material. The topography is usually level and the soils poorly drained and subject to the accumulation of injurious amounts of alkali salts.

Area and distribution of the soil of the Naylor series.

Soil name.	State or area.[1]	Acres.
Naylor silt loam	Washington 6	3,392

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils of the Northwestern Intermountain region, derived from alluvial fan and valley-filling material, are represented by one fine sandy loam, two loams, one gravelly loam, and one silt loam type, occurring under the Baker, Hutchinson, and Naylor series.

The topography varies from flat to moderately sloping. The surface in the more elevated areas is sometimes broken by ravines, gullies, or precipitous slopes of deeply eroded stream valleys. In general, however, it is of regular contour and favorable to the distribution of irrigation waters. Drainage is well established, except in some of the lower-lying areas along the foot slopes where seepage waters from irrigation accumulate, and in low-lying, depressed areas occupied by the Naylor silt loam. Alkali salts sometimes occur in injurious amounts in poorly drained areas. Climatic conditions are not generally favorable to the development of agriculture without irrigation. The larger unirrigated areas are utilized for grazing.

Where irrigated the soils are devoted mainly to general farm products consisting principally of wheat, oats, barley, alfalfa, timothy, and clover. Under favorable conditions the fine sandy loam is utilized to some extent for the production of potatoes, tree fruits, and vegetables, to which it is well suited. The loam types require a heavier farming equipment and more careful tillage than the fine sandy loam. Where well drained they are friable, easily cultivated, and retain moisture well. They are better adapted to the production of timothy or other grasses and to general farming of the heavier type than the fine sandy loam of the province. They are not usually so well suited to early fruit or vegetables, but well-drained areas of suitable topography can be used for late vegetables, apples, and pears with good results.

The gravelly loam type often contains a large content of gravel and sometimes an excessive amount of large bowlders or stone fragments. This material renders the type rather deficient in moisture-retaining capacity and subject to drought. Irrigation under such conditions becomes necessary at more frequent intervals than upon the normal loam members of the same series. Under similar conditions it will probably prove better adapted to fruits requiring early, well-drained soils than to general farming.

The silt loam, which is the only member occurring under the Naylor series, is of limited extent. It is poorly drained and but little utilized for agriculture. Where well drained and capable of irrigation it should prove suitable for the production of hay and grain crops.

Fine Sandy Loam Group.

Baker fine sandy loam.—The soil is a smooth fine sandy loam of light gray to light brown color. The subsoil is of yellowish brown color and is quite similar in general color and character to the soil material. The type consists of alluvial deposits derived predominantly from basaltic rock and distributed as alluvial slope or fan material by surface sheet wash or intermittent streams. The type possesses high capillarity, and where occurring under conditions of deficient natural drainage is, under irrigation, apt to accumulate alkali salts. Where well drained and irrigated it is well adapted to alfalfa, grains, fruit, and garden products.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Baker fine sandy loam	Oregon 2; California 7	17,280

[1] For key to numbers in this column see p. 733.

Loam Group.

Baker loam.—The soil is a light-gray to yellowish-brown loam, underlain by a yellow or yellowish-brown subsoil, generally of somewhat heavier texture and more compact structure in its deeper portions than the soil material. The type is of alluvial origin and derived from crystalline and basaltic rocks. It occupies alluvial slopes or plains and alluvial fans, and represents material transported by surface waters or by minor intermittent streams. Natural drainage is somewhat deficient under irrigation and the soil apt to accumulate alkali salts. Under favorable conditions grains, hay crops, fruits, and vegetables can be grown.

Hutchinson loam.—This type consists of a loam, sometimes approaching a fine sandy loam of rather loose porous structure, from 12 to 24 inches deep, underlain by a gritty subsoil of lighter color, compact structure, and heavy texture. Fine angular gravel is sometimes present in the soil section, often forming a hardpan in the subsoil. The type occurs upon mesa lands and lower foot slopes and is well drained and free from alkali. Under irrigation it is adapted to the production of alfalfa, clover, timothy, grains, and fruits.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Hutchinson loam	Oregon 1	30,784
Baker loam	do	10,816
Total		41,600

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

Hutchinson gravelly loam.—The surface soil consists of a dark-brown sandy loam to fine sandy loam with a gravel content ranging as high as 50 or 60 per cent. In the vicinity of stream channels the soil often becomes quite stony, consisting largely of bowlders with but little interstitial material. The upper subsoil is similar in general character to the surface soil and is underlain to a depth of 16 to 24 inches by gravel and bowlders or by rock conglomerate. The type consists of alluvial fan and foot-slope deposits of intermittent stream or sheet-surface waters. It occupies nearly level to moderately sloping areas, is generally well drained and free from injurious accumulations of alkali salts. Wheat, oats,

barley, clover, and alfalfa are the principal crops grown. More frequent irrigation is required than on the surrounding soils of heavier texture.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Hutchinson gravelly loam	Oregon 1	17,216

[1] For key to number in this column see p. 733.

SILT LOAM GROUP.

Naylor silt loam.—The surface soil is of variable texture, in places approaching a fine sandy loam. It has a gray color when dry and becomes dark drab when wet. The subsoil is similar to the soil and is usually underlain by bed rock or basaltic bowlders at a depth of 2 to 10 feet. The surface is generally level, poorly drained, and covered by alkali-resisting plants. Thorough drainage and the removal of alkali are necessary before any effective utilization of this type is possible.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Naylor silt loam	Washington 6	3,392

[1] For key to number in this column see p. 733.

RIVER FLOOD PLAIN MATERIAL.

The soils derived from the alluvial material of the River Flood plains and terraces are of comparatively small area, owing to the fact that the larger streams usually traverse deeply entrenched, narrow valleys. In some of the tributary valleys, particularly those entering the Columbia River from the west in Washington, quite extensive areas of stream-terrace deposits occur. These are highly developed to intensive agriculture under irrigation, and include portions of the fruit-producing districts of the Yakima and Wenatchee valleys.

The material from which the soils of the River Flood plains in this region are derived is predominantly of basaltic origin. In some of the deposits of the larger streams, often transported from great distances and from a source entirely outside the Northwestern Intermountain region, material derived from granitic or related quartz-bearing crystalline rocks is encountered. Material derived from sedimentary rocks enters into the alluvial flood plain and terrace soils of this region to but a limited extent.

Some of the soils of the province have been encountered in widely separated areas and are extensively developed. Others have been recognized only as of local and inextensive occurrence. The more important include those of the Yakima, Boise, Beverly, and Caldwell series.

The areas of soils derived from stream-laid deposits or River Flood plain material are most favorably situated of any of the region with regard to water supply and adaptability to irrigation. For this reason they are more highly developed, and in the agricultural districts to which the soil surveys have been mainly confined are represented by a relatively large number of soil series, some of which are extensively used for alfalfa or other general farm crops, hops, fruits, and other special products. They frequently constitute excellent orchard sites, being well protected from winds, and where occupying the sloping terraces are generally exempt from injurious frosts.

DESCRIPTION OF THE SOIL SERIES.

Beverly series.—The Beverly series embraces soils and subsoils of gray to grayish-brown color, often shallow and gravelly, and underlain by river-laid deposits of gravels and cobbles. The gravels and soil particles are well rounded and represent material derived from basaltic and crystalline rocks. The soils are generally moderately micaceous and the surface material of the lighter members often more or less wind blown. The series is of recent alluvial origin and occupies bottom and lower sloping terraces of stream valleys, often deeply eroded and narrow, and representing former flood plains. The members of the series are usually free from overflow and are generally treeless or but sparsely timbered. The topography varies from smooth to hummocky, and drainage is usually excessive.

Area and distribution of the soils of the Beverly series.

Soil name.	State or area.[1]	Acres.
Beverly sandy gravel	Washington 6	3,392
fine sand	do	4,096
gravelly fine sandy loam	do	1,536
Total		9,024

[1] For key to number in this column see p. 733.

Boise series.—The Boise soils are of light-gray to light-brown color. The subsoils are similar to the soils in color. They are underlain by a calcareous hardpan substratum and by beds of coarse gravels. The series is of alluvial origin, occupying stream flood plains and lower terraces. It is derived from basaltic rock. The types are well drained and where not underlain at too shallow depths by hardpan are adapted to alfalfa and fruits.

Area and distribution of the soils of the Boise series.

Soil name.	State or area.[1]	Acres.
Boise loam	Idaho 2	61,960
silt loam	do	95,850
Total		157,810

[1] For key to number in this column see p. 733.

Caldwell series.—The soils of the Caldwell series range in color from gray to dark gray or black. The subsoils are usually of somewhat lighter shade, varying from light gray to drab, and are underlain by a gravel substratum encountered at a depth of less than 6 feet. The series is of alluvial origin and derived from effusive volcanic rocks mainly of basic character, and from gneiss, schist, granite, shale, sandstone, and probably to some extent from limestones. The soils occupy stream bottoms and terraces of level to gently sloping topography. They are generally favorably situated for irrigation. The heavier members are ordinarily well supplied with organic matter. Some of the lower lying areas are poorly drained and subject to the occurrence of alkali salts, but as a rule drainage is well established and the soils free from overflow. They are not generally adapted to agriculture without irrigation, except in the lower lying areas of deficient drainage, which are devoted mainly to grazing and to hay crops. Small grains, timothy and other grasses, alfalfa, potatoes, sugar beets, tree fruits, and truck crops are grown.

Area and distribution of the soils of the Caldwell series.

Soil name.	State or area.[1]	Acres.
Caldwell fine sandy loam	Idaho 2, 3	35,212
loam	Idaho 1; Oregon 1; Washington 8.	274,368
gravelly loam	Washington 8	10,048
silt loam	Idaho 2, 3	17,436
Total		337,064

[1] For key to number in this column see p. 733.

Deer Flat series.—The soils are red and somewhat micaceous, with subsoils of sand or sandy loam similar in color to the soils. They are of alluvial origin derived predominantly from basaltic material and occupy stream flood plains and lower terraces. The topography is generally level and favorable to irrigation. Drainage is ordinarily well established and under irrigation the members are adapted to grains, hay, truck, and fruit.

Area and distribution of the soil of the Deer Flat series.

Soil name.	State or area.[1]	Acres.
Deer Flat fine sandy loam	Idaho 2	45,380

[1] For key to number in this column see p. 733.

Ewauna series.—The soils are dark brown to black and often of compact, refractory structure, with brown subsoils, which in turn rest upon a substratum of white or buff-colored chalk-like material, sometimes of calcareous character, but generally made up largely of siliceous diatomaceous earth material and volcanic ash deposited in the waters of former lakes. The soils are of alluvial origin and occupy flats or depressed areas in river flood plains. The material is derived mainly from basaltic rocks and deposits of volcanic ash laid down in the waters of ancient lakes. Drainage is often poorly established, but under favorable conditions most of the general farm crops can be grown.

Area and distribution of the soil of the Ewauna series.

Soil name.	State or area.[1]	Acres.
Ewauna clay adobe	Oregon 2	384

[1] For key to number in this column see p. 733.

Klamath series.—The soils are gray to dark gray or black, often containing a high content of organic matter, the darker colors becoming more pronounced when the soils are moist. The subsoils are gray to yellowish and of somewhat lighter texture than the soil. The series consists of alluvial material derived from the disintegration and decomposition of basaltic rocks, volcanic ash, diatomaceous earth and a large addition of organic material. Drainage is usually poor in this series, some form of reclamation being necessary before much of the land can be used for agricultural purposes. Where adequately drained grain, potatoes, timothy, and clover can be grown.

Area and distribution of the soils of the Klamath series.

Soil name.	State or area.[1]	Acres.
Klamath fine sandy loam	Oregon 2	2,048
loam	do	11,776
clay adobe	do	8,832
Total		22,656

[1] For key to number in this column see p. 733.

Langel series.—The soils are reddish brown to light brown in color, frequently tenacious and compact in structure, and vary in depth from 15 to 30 inches. The subsoils are of yellowish-brown or light-brown color, of rather heavy texture, and contain a large proportion of diatomaceous earth. In places they are underlain at less than 6 feet by a substratum of light-gray chalky material mixed with volcanic ash, occasionally calcareous and carrying embedded pebbles. The series is of alluvial origin, derived largely from the erosion of basaltic material and volcanic ash occupying the higher slopes. The series occupies gently sloping to flat areas in river flood plains or stream-laid valley plains. The soils are generally well drained and retentive of moisture and under favorable irrigation and climatic conditions are adapted to alfalfa, grains, potatoes, and orchard crops.

Area and distribution of the soils of the Langel series.

Soil name.	State or area.[1]	Acres.
Langel fine sandy loam	Oregon 2; California 7	70,464
loam	do	6,912
Total		77,376

[1] For key to number in this column see p. 337.

Link series.—The soils and subsoils are of white or light-gray color, both being formed largely of diatomaceous earth. This is of chalky character, sometimes calcareous, and generally contains an admixture of volcanic ash. The series is of alluvial origin and occupies river flood plains and lower stream terraces. The soils are sticky when wet and of flourlike texture when dry. A superficial layer of sand or finer sediments often covers the surface. The types are often poorly drained and affected with alkali salts. Fair crops of alfalfa are grown under favorable conditions of irrigation and drainage.

Area and distribution of the soil of the Link series.

Soil name.	State or area.[1]	Acres.
Link clay loam	Oregon 2	15,680

[1] For key to number in this column see p. 733.

Red Rock series.—The soils and subsoils are of light or drab to yellowish-brown color when dry, becoming darker when moist. They are sometimes gravelly and are underlain by a substratum of gravel and cobbles. The topography is nearly flat to sloping or sometimes slightly irregular or duny. The members of the series are often poorly drained and frequently subject to overflow or to the accumulation of alkali salts. They are derived predominantly from basaltic material, which in the Quincy area, Washington, consists of glacial outwash deposits. The soils are of moderately recent alluvial origin, but have been subject to some addition and intermingling of wind-blown material and at the base of steep inclosing bluffs of colluvial material. The soils occupy stream bottoms and lower terraces, supporting only desert vegetation.

They are distinguished from the Beverly series by the prevailing darker color of the soil and subsoil and by being more frequently poorly drained and subject to overflow.

Area and distribution of the soils of the Red Rock series.

Soil name.	State or area.[1]	Acres.
Red Rock fine sandy loam	Washington 6	3,456
clay	do	6,336
Total		9,792

[1] For key to number in this column see p. 733.

Wind River series.—The soils are light brown to brown, and characterized by the occurrence of soft, weathered basaltic fragments and small, spherical pellets or aggregates of mineral particles cemented by iron solutions. The subsoils are light brown to yellowish brown, sometimes compact, and underlain at depths ranging from 4 to 50 feet by basaltic bedrock or more frequently by a substratum of stratified gravels resting upon the basaltic bedrock. Subangular to rounded bowlders and gravels are of frequent occurrence throughout the soil profile. The series occupies stream terraces well elevated above present flood terraces, of level to undulating topography, and marked by steep and rocky terrace slopes. The soils are of alluvial origin and derived mainly from basaltic material. Drainage is well established. The forest growth is rather limited.

Area and distribution of the soils of the Wind River series.

Soil name.	State or area.[1]	Acres.
Wind River sandy loam	Washington 7	1,024
gravelly sandy loam	do	9,984
fine sandy loam	do	1,024
loam	do	1,280
gravelly loam	do	1,536
Total		14,848

[1] For key to number in this column see p. 733.

Yakima series.—The soils of the Yakima series range from light gray or grayish brown to yellowish brown or light brown in color, and extend to a depth of 6 feet or more. They are often porous and sometimes of ashy structure, carrying strata or pockets of volcanic ash and occasionally waterworn gravel or glacial bowlders. Drainage is usually well developed and in places excessive. The topography ranges from gently sloping or undulating to level, the soils occupying stream bottoms and terraces. The soils are of alluvial origin, the immediate surface material being derived from basaltic or other eruptive rocks. The members of the series are usually treeless and occupy desert plains.

Area and distribution of the soils of the Yakima series.

Soil name.	State or area.[1]	Acres.
Yakima fine sand	Idaho 2	17,430
fine sandy loam	Idaho 4; Washington 9	181,452
loam	Idaho 4	12,736
Total		211,618

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

SANDY GRAVEL PHASE.

The fine interstitial material of this phase of the sand group consists predominantly of sand or fine sand, but carries a sufficiently high content of gravel and cobbles to essentially alter the normal character of the soil.

Material of this character has been encountered in only one locality, and occurs under the Beverly series. It is of loose, porous structure, and deficient in moisture-retaining capacity. The content of gravel and cobbles is usually sufficient to interfere with cultivation. The type is not adapted to general agriculture, and is not utilized to any extent. It is, however, favorably situated for irrigation, and with a liberal supply of water for this purpose might be used for the production of early fruits.

Beverly sandy gravel.—The surface soil, to a depth of 12 to 15 inches, consists of a compact mass of rounded gravel of various sizes, containing a variable amount of rounded cobbles and small bowlders.

Considerable fine sand is mixed with this coarse material, which gives the soil a gray to light grayish-brown color. The subsoil consists of a compact mass of gravel, cobbles, and small, rounded bowlders extending to a depth of 6 feet or more. The topography varies from level to gently sloping, undulating or irregular and duny. The type is but slightly elevated above present stream channels, but only small areas are subject to overflow. Drainage is excessive, and the type is not adapted to farming except under irrigation. There is enough sandy material present in the soil to enable it to be utilized to a limited extent for agricultural purposes. Practically the entire area of this type can be irrigated. With sufficient water supply the type can be used for fruit.

Area and distribution of the sandy gravel.

Soil name.	State or area.[1]	Acres.
Beverly sandy gravel	Washington 6	3,392

[1] For key to number in this column see p. 733.

Fine Sand Group.

The soils of the fine sand group have not been widely encountered, and are represented in but two of the more important soil series of the province.

The soil material is of loose, porous structure, and in exposed localities the surface is frequently wind drifted where not protected by windbreaks or other vegetation. Cultivation is easy, and only light farming equipment required. The subsoil is generally porous and both surface and underdrainage usually well established. Some of the lower-lying areas are occasionally subject to overflow during periods of high water. Only a portion of the area covered by the soils of this group is at present utilized, owing to the lack of irrigation facilities. The soils are deficient in moisture-retaining capacity and subject to drought where not frequently irrigated. Irregular and wind-blown areas require considerable leveling before irrigation can be practiced. Alfalfa, truck, and fruit crops are most extensively grown, alfalfa proving a profitable crop under favorable conditions of irrigation. The general farm crops do best on the heavier soils. Under favorable conditions of climate, irrigation, and market facilities they are best utilized for the production of early stone fruits, early table grapes, melons, and early truck crops.

Beverly fine sand.—The typical soil to a depth of 12 to 15 inches is of loose, incoherent structure and usually distinctly micaceous. It sometimes carries noticeable amounts of coarse and medium sand. The subsoil consists of a fine sand, slightly more compact than the surface soil and lighter in color, which rests upon a compact mass of gravel and small bowlders at an average depth of 2½ to 5 feet. Small amounts of gravel sometimes appear in the surface material. The type occupies first bottom or lower sloping terraces, slightly elevated above present stream channels, but seldom subject to overflow. The surface varies from level or gently sloping to wind blown and hummocky. It is generally well drained and subject to drought, but irrigable where water supply is available.

Yakima fine sand.—This type is a fine sand of loose, porous structure, ranging from a few inches to several feet in depth. It is similar to the Yakima sand in color, topographic position, origin, and mode of formation, but is generally less subject to wind drifting. The soil is well drained, free from alkali, and where capable of irrigation and cultivation is adapted to tree fruits, truck crops, berries, alfalfa, and clover.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Yakima fine sand	Idaho 2	17,430
Beverly find sand	Washington 6	4,096
Total		21,526

[1] For key to numbers in this column see p. 733.

Sandy Loam Group.

Only a single member of this soil group has as yet been encountered. It is of comparatively limited extent, occupying stream terraces on the eastern slopes of the Cascade Mountains.

The soil is friable and easily handled, resting upon a sandy loam or loamy sand subsoil, underlain at considerable depths by gravel. Drainage is excessive and the moisture-retaining capacity of the soil low. Some of the intensively cultivated crops might be grown without irrigation, but the normal rainfall is scanty and crop returns are uncertain. Only small areas of the type are under cultivation at present.

The soil usually supports a forest growth, and some labor in clearing is necessary in preparing the land for cultivation. Once prepared for irrigation, only a light farming equipment is needed in caring for crops. Under such conditions alfalfa, potatoes, fruits (including early apples), and some of the lighter and earlier types of vegetables can be grown. The type is not well adapted to heavy general farming purposes.

Wind River sandy loam.—The surface soil consists of a medium sandy loam from 15 to 24 inches deep. The subsoil is a yellowish-brown sandy loam or loamy sand of considerable depth, which in turn rests upon a gravel substratum. Sometimes bedrock occurs at a depth of 6 to 10 feet, and in such cases the gravel deposits are absent. A small amount of mica and a few basaltic gravel are found in both the soil and subsoil. Natural drainage is thorough and in some cases excessive. The type is somewhat deficient in moisture-retaining capacity, but well adapted to a wide range of crops under irrigation, including alfalfa, potatoes, small and tree fruits, etc.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Wind River sandy loam	Washington 7	1,024

[1] For key to number in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam soils in this province, like those of normal sandy loam texture, have not been extensively encountered and are represented by a single type of the Wind River series.

The soil contains a large amount of gravel, making the structure more open and porous than is the case with the sandy loam, which, with prevailing conditions of excessive drainage, decreases its moisture-retaining capacity and becomes droughty. The gravel content, however, decreases in the subsoil, the deeper portion being usually of fine texture and of fairly compact structure, a feature which to a certain extent counteracts the tendency toward excessive loss of moisture under irrigation. The gravelly sandy loam is not extensively

cultivated, as irrigation is essential to any successful form of agriculture. When properly irrigated it is adapted to about the same crops as the normal sandy loam in the same soil series.

Wind River gravelly sandy loam.—The surface soil varies in depth from 12 to 18 inches and contains a large amount of angular to subangular gravel. The subsoil is a light-brown to yellowish loam or sandy loam, the gravel content being lower than in the surface soil. The amount of gravel decreases and the silt content increases with depth, until at 30 inches the subsoil often has the texture of a silt loam. Mica particles are found throughout the soil profile in small quantities. The terraces occupied by this type range in elevation from 10 to 200 or 400 feet above the present stream level. The topography varies from level to gently undulating. Drainage is apt to be excessive and the soil deficient in moisture-retaining capacity. Irrigation is a necessary adjunct to any form of successful agriculture. Where irrigated alfalfa and numerous varieties of fruits can be grown.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Wind River gravelly sandy loam	Washington 7	9,984

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

The soils occurring under this group are represented in widely separated areas and constitute one of the most extensive and important soil groups of the Northwestern Intermountain region. Some members of the group have been encountered only as local inextensive bodies and are of minor agricultural importance. Those occurring under the more important soil series, however, are frequently extensively developed and are in a high state of intensive cultivation.

Conditions of drainage, irrigation, character of underlying material, and other important features in the utilization of the soils vary widely in the several areas in which the fine sandy loams have been encountered. The soils are usually free from overflow and fairly well drained. One or two members of the group, occupying lower terraces on areas of flood plains adjacent to stream courses, are subject to overflow or are poorly drained, while in the irrigated districts extensive areas of the soils have in some instances suffered from the accumulation of seepage waters, sometimes accompanied by an excess of mineral salts from higher-lying slopes.

The surface is usually smooth, nearly level or gently sloping, and admirably adapted to the distribution of water for irrigation. On many areas irrigation facilities have been extensively developed at a comparatively low cost by diverting water from adjacent streams and a highly intensive form of agriculture developed.

In the areas more favorably situated with regard to rainfall dry-farmed crops are successfully grown, although irrigation is generally essential on most of the areas in which the fine sandy loams have been encountered.

The soils are friable under cultivation and under favorable conditions of drainage and irrigation are readily maintained in a friable, mellow tilth. Only a moderately heavy farming equipment is necessary and the soils may be economically and effectively utilized in small, intensively cultivated tracts. They are well suited under irrigation to general farming purposes as well as to more intensively cultivated fruit and other special crops. They probably have a wider crop adaptation than any of the soils of the Northwestern Intermountain region. The principal general farm crops include alfalfa, oats, wheat, timothy, clover, and potatoes. When favored by climate, transportation, and market facilities, extensive areas are devoted to apples, pears, peaches, plums, cherries, hops, table grapes, strawberries, and other small fruits, melons, cantaloupes, and truck crops. Grass crops do well on poorly drained areas, but the soils are in general not so well adapted to these crops and to other general farming purposes as the heavier soil types. They are profitably utilized in the production of alfalfa and for a light type of general farming, but when climatic and

irrigation conditions are favorable are more highly esteemed for the culture of fruits, small fruits, and truck crops of choice quality and high market value.

Deer Flat fine sandy loam.—This is a red, micaceous fine sandy loam varying in depth from a few inches to 3 feet and underlain by a sandy loam or sand from 50 to 100 feet deep. The type occurs in higher lying valley areas and has a generally level surface. The soil is free from alkali, but only a small proportion is cultivated, owing to lack of water for irrigation. It is a good soil for truck, grain, clover, and fruit.

Caldwell fine sandy loam.—The soil consists of a fine sandy loam of light gray or light brown to a darker gray or brown color. The subsoil is similar in color and texture to the soil and in turn is underlain by a stratum of gravel or sand at a depth of less than 6 feet. The soil is slightly porous in structure and rather deficient in moisture-retaining capacity, except where intensively cultivated. It is of alluvial origin and derived from basalt, quartz-bearing, crystalline, and sedimentary rocks. It occupies level to slightly sloping stream terraces and is usually free from overflow. Surface drainage is sometimes poorly established, but the type is favored by excellent subdrainage except where the water table approaches the surface. Lower lying and poorly drained areas are utilized mainly for grazing and hay crops. Under favorable conditions of irrigation and drainage the type is well adapted to alfalfa, truck crops, and fruits. Cantaloupes, melons, peaches, cherries, plums, and table grapes are extensively grown in favorably located areas.

Klamath fine sandy loam.—The surface soil is a dark-gray to almost black fine sandy loam about 15 inches in depth, underlain by a light-gray fine sandy loam 6 feet or more in depth. It occupies overflow land near stream courses. Between the soil and subsoil a thin cemented layer is sometimes encountered. The type is comparatively free from alkali, although in some instances black alkali is found. Usually sage and rabbit brush are the native vegetation. Alfalfa, grain, and garden truck are the principal crops.

Langel fine sandy loam.—The soil has a light-brown to reddish-brown color when dry, which becomes darker when moist. The subsoil is light brown to yellowish brown or gray, the deeper portions being light yellow or buff to light gray. The subsoil is composed largely of chalky, diatomaceous material and volcanic ash, resting upon a substratum of compact chalky beds, sometimes of calcareous character and containing embedded waterworn pebbles. The type is of alluvial origin and occupies level to gently sloping recent flood plains or earlier alluvial stream-laid valley plains. It is derived from basaltic material, diatomaceous earth, and volcanic ash. Drainage is generally fairly well established, and under favorable conditions of climate, drainage, and irrigation it is adapted to alfalfa, grains, potatoes, and fruits.

Red Rock fine sandy loam.—The soil is typically of a gray to grayish-brown color, of compact structure, and from 12 to 24 inches deep, sometimes having a noticeable gravel content. The subsoil has a slightly lighter color than the soil and consists of a compact fine sandy loam usually extending to a depth of 6 feet or more. It is sometimes underlain at 3 to 6 feet by waterworn gravels. The type is of alluvial origin, and occupies flat to gently sloping areas of stream bottoms and low terraces. It is derived from basaltic material. The surface is often somewhat irregular or wind blown. The type is sometimes poorly drained and alkaline.

Wind River fine sandy loam.—The soil is usually 8 to 12 inches deep and of rather light-brown color. The subsoil is a light-brown to yellowish-brown loam, often mottled with shades of brown and yellow. It becomes heavier and more compact with depth. The underlying gravelly substratum occurs at a depth of about 10 feet. Both the soil and subsoil contain a small amount of mica particles, and a few subangular basaltic bowlders are found on the surface. The terraces occupied by the type frequently have an elevation of 300 or 400 feet above the present stream flood plains. The terrace slopes are often quite steep, but the surface is level to gently rolling. Natural drainage is thorough but not excessive, and the type is retentive of moisture. With thorough cultivation the type can be successfully farmed without irrigation and is adapted to strawberries and other small fruits, apples and other tree fruits, and general farm crops.

Yakima fine sandy loam.—The type consists of a gray, light, friable, fine sandy loam from a few inches to many feet in depth. Alternating strata of fine sand and fine sandy loam, with considerable gravel, occur throughout the lower portion of the soil section. Where the soil is shallow it rests directly upon basaltic bedrock. Strata of volcanic ash frequently occur at varying

depths throughout the soil section in beds varying from a few inches to 2 feet in thickness. The type generally occurs in extensive bodies, occupying elevated slopes and valley plains. On account of its friable, porous structure it is easily eroded. Drainage is well established and the soil free from alkali, except where subject to seepage waters from higher lands. It is adapted to hops, alfalfa, clover, timothy, fruits, and cereals.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Yakima fine sandy loam	Idaho 4; Washington 9	181,452
Langel fine sandy loam	Oregon 2; California 7	70,464
Deer Flat fine sandy loam	Idaho 2	45,380
Caldwell fine sandy loam	Idaho 2, 3	35,212
Red Rock fine sandy loam	Washington 6	3,456
Klamath fine sandy loam	Oregon 2	2,048
Wind River fine sandy loam	Washington 7	1,024
Total		339,036

[1] For key to numbers in this column see p. 733.

GRAVELLY FINE SANDY LOAM PHASE.

The soils of the gravelly fine sandy loam phase are represented in this province by a single member of limited extent. The high gravel content and prevailing topography cause drainage to be excessive, making the soil inferior in moisture-retaining capacity to the normal soils of the fine sandy loam. The range in crop adaptation is more limited, and it is not suited to general farming purposes. Under frequent irrigation stone fruits and possibly early apples and pears could be grown. At present the soil is not utilized to any extent.

Beverly gravelly fine sandy loam.—The surface soil varies in depth from 12 to 20 inches and carries a considerable amount of water-worn gravel intermingled with the soil material. It is underlain by a compact mass of rounded gravel and cobbles with interstitial sands and fine gravels, which extends to a depth of 6 feet or more. The type is not subject to overflow. The topography varies from gently sloping to undulating. Drainage is good and much of it can be used for fruit growing under irrigation.

Area and distribution of the gravelly fine sandy loam.

Soil name.	State or area.[1]	Acres.
Beverly gravelly fine sandy loam	Washington 6	1,536

[1] For key to number in this column see p. 733.

Loam Group.

The soils of the loam group are extensively developed throughout the region and with the members of the fine sandy loam group constitute the principal agricultural soils of the province. They occur under a number of soil series, some of the members appearing in several of the areas surveyed, while others are confined to a single locality of small extent and of minor agricultural importance. The more important members of the group occur under the Caldwell and the Yakima series.

The conditions of drainage, depth of soil, character of underlying material, and topography, more particularly as affecting irrigation, do not differ materially from those of the fine sandy loam soils. Surface drainage is in some cases rather poorly established, and the movement of water takes place somewhat more slowly through the soil and subsoil material than with the fine sandy loams. Lower-lying areas of slight slope are often subject to the accumulation of seepage waters and alkali salts. In the Klamath series the loam is characteristically poorly drained and carries a large amount of organic matter. Upon the other hand, in the Wind River series, drainage is rather excessively

developed in the localities where the loam has been encountered. Climatic conditions are not usually favorable to agriculture without irrigation, but dry farming is carried on to a limited extent in areas of more than average precipitation or in low-lying, moist areas of deficient drainage. In the Boise series, hardpan is of frequent occurrence in the subsoil material, which tends to seriously retard subdrainage and the penetration of plant roots under irrigation.

The soil is sometimes decidedly sticky when wet and requires more thorough drainage, a heavier farming equipment, and more careful cultivation than the fine sandy loams of the province. Under favorable drainage and tillage conditions it is usually friable and generally superior to the fine sandy loams in moisture-retaining capacity.

The soils of the group are devoted mainly to general farming purposes. Where properly drained and irrigated, local areas having good market facilities are utilized intensively for vegetables and fruits. The soils are well suited to the later and heavier vegetables and to late berries, currants, and other small fruits. Tree fruits are widely grown for home use, but commercial production has not been extensively developed. Conditions are generally favorable for the extension of apple orcharding, to which the soil is well adapted. The stone fruits find conditions more suitable upon the fine sandy loams or lighter types of the province, although successfully grown to a limited extent upon the loams. Alfalfa, clover, wheat, oats, barley, timothy, and other grass crops constitute the principal general farm products. Potatoes and sugar beets are quite extensively grown in certain of the areas mapped.

Boise loam.—This type consists of a red or yellow loam from 6 inches to several feet in depth, underlain by alternating strata of sandy loam and sand, the latter often being cemented into a hardpan by calcium carbonate. The particles in the upper stratum of the soil are also usually cemented together, but not into a compact mass. The surface few inches consist of a mantle of sandy loam of varying depth. The type occurs on mesa plains and is derived in part from erosion of lake sediments. Alkali is often present. When the subsoil is broken up the type can be used for grains, fruit, and alfalfa.

Caldwell loam.—This type consists of a dark-gray, brown to dark-brown, or nearly black loam from 3 to 6 feet deep, of a fine silty texture, and friable under cultivation. The subsoil consists of gravelly loam, water-worn gravel, or gray to yellow sticky loam, grading into gravelly loam or river gravel in the lower portion. The lighter phases are frequently of porous structure and ashy texture. The type occupies extensive areas covering low-lying plains or terraces and stream flood plains, is subject to overflow, and sometimes poorly drained. Both soil and subsoil are sometimes marked by pockets of volcanic ash. The type is composed of recent stream alluvium with an admixture of older lacustrine material. The organic-matter content is high. In the poorly drained districts the soil is sometimes impregnated with alkali. Where cultivated it is adapted to vegetables, hay, and grain.

Klamath loam.—This type consists of a gray to dark-gray loam about 2 feet deep, underlain by a light-gray loam or fine sandy loam continuing to a depth of 6 feet or more. In some portions of the type beds of chalk or tufaceous and diatomaceous material are encountered at depths of 4 to 5 feet. The type lies adjacent to streams, marshes, and lakes and is usually poorly drained. The areas of dark-gray color contain large quantities of organic matter, which give the material a silty appearance. A distinct phase of this type occurs in places which have been under water for a considerable period, forming accumulations of Muck with a soil approaching a mucky loam in texture and which appears to grade gradually into the Peat types of the swamps and marshes. A large portion of the type is free from alkali, but areas in the neighborhood of the marshes having a mucky loam top soil are often crusted with alkali to the depth of several inches. Native grasses and considerable quantities of sage and rabbit brush cover this soil. It is dry farmed to grain and potatoes to a limited extent. Alfalfa is not so well adapted to it, but timothy, redtop, alsike clover, and root crops do well.

Langel loam.—The soil is of reddish-brown color and usually carries a high proportion of fine sand in the surface 3 or 4 inches. It is rather sticky when wet, puddles and bakes upon exposure, but is friable when worked under favorable moisture conditions. The subsoil is of yellowish-brown color and quite similar in texture to the soil material. It consists largely of chalklike, diatomaceous earth and volcanic ash and is often underlain at less than 6 feet by light-colored, chalklike beds of the same character of material. The type is

of alluvial origin, fairly well drained, and retentive of moisture. It is adapted to fruits, grains, and alfalfa.

Wind River loam.—The surface soil is from 16 to 18 inches deep, carrying angular and rounded basaltic rock fragments and bowlders. The subsoil is similar in texture to the surface material but usually of slightly lighter color and of more compact structure. The type occupies level to undulating terraces, rising steeply from the stream bottoms. The native forest growth consists mainly of scrub oak and small pine. The type is well drained and the shallow areas somewhat subject to drought. Under irrigation it is well adapted to tree fruits. The deeper phases can be used for this purpose without irrigation.

Yakima loam.—The surface soil consists of a light loam of fine silty texture and porous structure, approaching a fine sandy loam under field conditions. It is light-brown to buff or gray in color, generally extending to a depth of 2 to 4 feet. The subsoil is yellow to light brown in color. The type is well drained and free from alkali, and where capable of cultivation is adapted to alfalfa, timothy, clover, and grains.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Caldwell loam	Idaho 1; Oregon 1; Washington 8	274,368
Boise loam	Idaho 2	61,960
Yakima loam	Idaho 4	12,736
Klamath loam	Oregon 2	11,776
Langel loam	California 7	6,912
Wind River loam	Washington 7	1,280
Total		369,032

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase of the loam group of soils, so far as encountered, includes but two members of limited extent, which have been recognized only in two areas surveyed.

Owing to its gravel content the soil material is more readily permeable than that of the normal loams of the province. Drainage is more thoroughly established and the soils have a somewhat lower water-holding capacity. They are ordinarily more friable under cultivation and under favorable conditions of cultivation are fairly retentive of moisture. Where encountered they usually support a timber growth and considerable labor is necessary in clearing and preparing the land for cultivation. Some of the lower-lying areas occurring under the Caldwell series are sometimes subject to overflow, but the soils usually lie well above present stream channels, and in the Wind River series are usually confined to high terraces.

The gravelly loams are not extensively utilized, but are devoted to some extent to the production of grains, hay, fruits, and vegetables.

Under favorable conditions of climate and irrigation, the soils are well suited to the production of apples, peaches, cherries, plums, and small fruits. They are generally better suited to fruit culture than the normal loams of the province, but are usually inferior for general farming purposes.

Caldwell gravelly loam.—The surface soil is a compact, moderately heavy sticky loam, dark gray to dark brown in color and varying in depth from a few inches to 3 feet. It carries a large amount of flattened or rounded gravel, chiefly of basaltic or other volcanic rocks, ranging in size from a fraction of an inch to the size of cobbles. The subsoil consists of a light-gray, fine-textured, sticky, gravelly loam, grading to gravel beds, or frequently underlain directly by beds of river sands and reworked pebbles and cobbles often partially cemented by lime. The type generally occurs as extensive areas covering nearly level or slightly sloping stream flood plains or valley bottoms skirting stream channels. The surface is broken only by shallow stream channels or minor stream-formed terraces and is frequently covered by heavy thickets of willow and light timber. The soil is well drained, except in the level areas, which are subject to overflow. The type is formed by a mixing of recent stream alluvium with original gravel sheets underlying lake beds. The soil is

frequently too shallow and gravelly to admit of profitable cultivation, but the better areas are adapted to grains and hay. The soils of this series are used for the production of a wide variety of small fruits, tree fruits, and truck crops.

Wind River gravelly loam.—The soil consists of a rather light brown to brown loam from 12 to 18 inches deep, containing a large amount of organic matter and large quantities of subangular gravel. The subsoil is a brown loam of smooth texture, generally somewhat heavier than the surface soil and also carrying considerable gravel. A few cobbles and bowlders usually occur upon the surface or distributed throughout the soil section, being most numerous in the vicinity of stream slopes where erosion has been active. At a depth of 5 feet or more the soil material rests upon stratified beds of gravel. The type sometimes attains an elevation of 300 to 500 feet above the present stream flood plains. Although the terrace slopes are often steep, the type as a whole has a level to very gently rolling topography. The natural drainage is very thorough, but not excessive, and the type is less subject to drought than the lighter members of the series. It is adapted to general farming and to apples, peaches, cherries, and other fruits.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Caldwell gravelly loam	Washington 8	10,048
Wind River gravelly loam	Washington 7	1,536
Total		11,584

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

The silt loam in this province has been recognized under two soil series. This type more frequently occupies a lower-lying position than the lighter textured soils of the province. Drainage is in some cases poorly established and some of the areas are occasionally subject to overflow or characterized by the occurrence of hardpan. Lower-lying areas are generally used for pasture or seeded to timothy and other grasses. Some wheat and alfalfa are also grown. The poorly-drained areas are best suited to grass crops. The type is well suited to heavy general farming purposes, but when poorly drained is subject to a rather limited crop adaptation. Under favorable drainage conditions grain, alfalfa, sugar beets, forage crops, late or heavy vegetables, and small fruits can be grown. It requires a somewhat heavier type of farming equipment than the loams and thorough and judicious cultivation for the maintenance of favorable conditions of tilth.

Boise silt loam.—The type consists of a light-gray, loose, ashy, and micaceous silt loam ranging in depth from a few inches to 40 or 50 feet. To a depth of 6 feet it is often interstratified with loam, sand, or sandy loam or lime-cemented hardpan, the sandy loam extending in places to bedrock. The soil rests upon beds of coarse gravel and cobbles. The type occupies mesa lands and is composed of lake sediments, probably of basaltic origin. Some alkali occurs in local spots in the loam subsoil. The soil is well drained and is adapted to truck, grain, and clover. Where the hardpan is not very thick fruit and alfalfa do well.

Caldwell silt loam.—The surface soil consists of a dark-gray or brown to black heavy, sticky silt loam, sometimes containing gravel, and from 10 to 36 inches deep. It has rather a compact structure, but is generally friable under cultivation. The subsoil varies from a dark-gray to black or light-colored, heavy, sticky silty loam, generally of rather compact, adobelike structure, and extending to a depth of 6 feet or more, which is in turn underlain by rounded river gravels. The type occupies the nearly level valley depressions, river flood plains, and stream bottoms, the areas being often marked by willow thickets or small timber and cut by meandering stream channels. The soil is often subject to overflow, is usually poorly drained, and sometimes contains alkali. The type is composed of stream sediments derived from earlier lake beds. The soil is

generally rich in organic matter and frequently approaches the consistency of Muck. It is used for pasture, hay, grains, vegetables, and forage crops.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Boise silt loam	Idaho 2	95,850
Caldwell silt loam	Idaho 2; 3	17,436
Total		113,286

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loam group in this province is represented by a single member which has been recognized in but one area.

The topography, texture, and structure of the soil are such that drainage is generally poor and many areas are subject to injurious accumulations of alkali. The organic matter content is low and the soils generally unproductive and of minor agricultural importance. Under favorable conditions of irrigation and drainage, the type can be utilized to some extent for general farming purposes, alfalfa constituting the principal product. The soil and subsoil are composed largely of diatomaceous earth and volcanic ash material, sticky and tenacious when wet and requiring careful management. Artificial drainage, careful cultivation, and a systematic use of stable and green manures are necessary to secure best results.

Link clay loam.—The surface soil is light ashy gray to white, sticky when wet but friable and floury when dry. A thin mantle of alluvial sediments usually imparts a slightly darker color to the surface few inches of the soil profile. The subsoil is similar to the soil material in all essential characteristics. The type is of alluvial origin, consisting mainly of chalk-like diatomaceous earth and volcanic ash, the result of erosion from adjacent higher-lying slopes. It occupies flat or depressed areas in alluvial stream-formed valley plains. Drainage is often poor and the soil subject to accumulation of alkali salts. The organic-matter content is limited. Its agricultural value is low, although fair crops of alfalfa can be produced under favorable conditions.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Link clay loam	Oregon 2	15,680

[1] For key to number in this column see p. 733.

Clay Group.

The clay group is represented only by the clay member of the Red Rock series.

This soil is of small extent and is generally poorly drained. The surface is often irregular and when prepared for irrigation, requires considerable labor in leveling. Alkali salts in injurious quantities are present in the lower lying areas. Artificial drainage and irrigation are necessary before any extensive agricultural operations are possible. Under such conditions the heavier farm crops can be grown. The soil is refractory and requires a heavy farming equipment, frequent cultivation, and liberal applications of manure.

Red Rock clay.—The surface soil is a dark-gray to drab or slate-colored compact clay, becoming darker when moist. At a depth of 3 feet or more it is usually underlain by a gray or drab compact fine sandy loam, in places carrying thin strata of silty material and sometimes approaching a hardpan structure. The topography is level to gently undulating and the surface sometimes duny or covered with a thin veneer of sandy material deposited by winds or washed from adjacent soils. Drainage is poor and accumulations of alkali salts

are of frequent occurrence. The soil is alluvial in origin, and derived from basaltic material, much of which has probably been deposited under swampy conditions. The type occupies stream flood plains and lower terraces.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Red Rock clay	Washington 6	6,336

[1] For key to number in this column see p. 733.

CLAY ADOBE PHASE.

The clay adobe phase of the clay group of soils is represented by two members which are of inextensive occurrence and confined to a single area.

The pronounced adobe structure, normal heavy texture, and deficient drainage, make these soils very tenacious and difficult to handle, except under proper moisture conditions. Upon drying they tend to bake and check, in which condition they can not be effectively cultivated.

They are not extensively utilized and are of minor importance in the region. When well drained and irrigated they can, with careful management, be used for the general farm crops. They require a heavy farming equipment and careful adjustment of conditions of moisture and tillage.

Ewauna clay adobe.—The surface soil consists of a dark-brown to nearly black heavy adobe, becoming sticky when wet, and readily puddling and baking under exposure. It is refractory under cultivation and a good tilth is maintained with some difficulty. The subsoil is similar in color and structure to the overlying material and rests at a depth of 2 to 4 feet upon a substratum of light-colored chalky material formed largely of siliceous diatomaceous earth and volcanic ash, which may in places be slightly calcareous. The type is of alluvial origin, derived from basaltic and volcanic ash and deposited by streams over river flood plains. It is often poorly drained and occupies gently sloping to depressed areas. Under favorable conditions of cultivation and moisture it is adapted to the general farm crops.

Klamath clay adobe.—This type consists of a dark-gray or black clay adobe, 30 inches deep, underlain by a lighter textured yellow clay extending to a depth of 6 feet or more. It has a true adobe structure with cracks extending downward through the soil to the subsoil. Accumulations of alkali are found in some portions of the type, though such deposits are not characteristic.

Area and distribution of the clay adobes.

Soil name.	State or area.[1]	Acres.
Klamath clay adobe	Oregon 2	8,832
Ewauna clay adobe	do	384
Total		9,216

[1] For key to number in this column see p. 733.

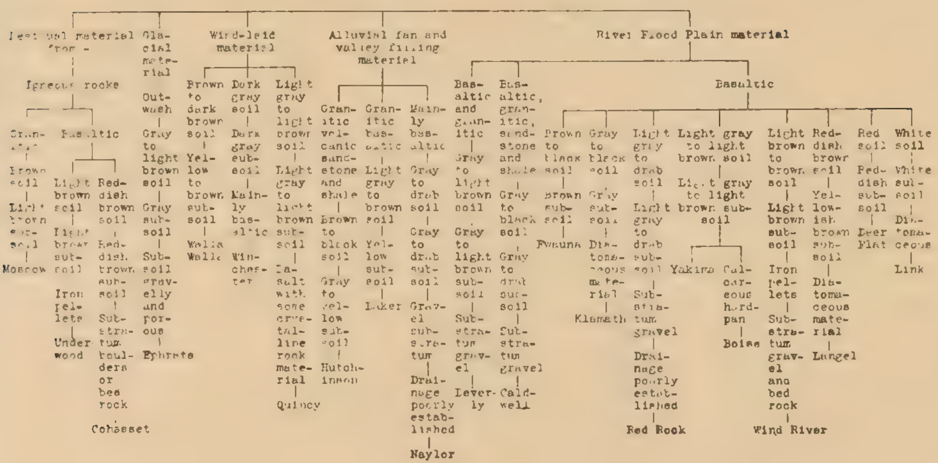
MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Dunesand	Washington 6	39,680
Meadow	Idaho 4; Oregon 1; Washington 6, 9	30,996
Rough broken land	Washington 6	14,656
Riverwash	Idaho 1, Washington 9	5,372
Peat	Oregon 2	384
Rock outcrop	Oregon 1	192
Total		91,280

[1] For key to numbers in this column see p. 733.

Key to the Soils of the Northwestern Intermountain Region.



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SOILS OF THE GREAT BASIN REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

For the purposes of soil classification the Great Basin is regarded by the soil survey as nearly coincident with the physiographic province of the Great Basin of interior drainage.

It embraces all Nevada with the exception of the extreme southeastern parts, the western part of Utah, a small part of southeastern Idaho, the south-central part of Oregon, and the greater part of the eastern margin of California, with an extensive area in the southeastern portion of that State. With the exception of the waters of Goose Lake in northeastern California and south-central Oregon, which occasionally overflow to the Pacific, no drainage waters within the confines of this region find their way to the sea, but are removed by evaporation. Aside from a few streams flowing westward from the Wasatch Mountains and adjacent plateaus included within the Rocky Mountain region, as defined by the soil survey, but little drainage enters the region from outside sources.

The limits of the Great Basin region are sharply delineated upon the east by the abrupt fault scarps and cliffs of the elevated Wasatch, Sevier, Gunnison, and contiguous plateaus which constitute portions of the territory included within the Rocky Mountain region. Upon the southeast the Great Basin merges with that part of the arid Southwest region drained by the Colorado River system. Its southern boundary is marked in part by the region of the arid Southwest, but principally by the northern and eastern slopes of the San Bernardino and Sierra Madre Mountains of southern California. Its western boundary is fixed by the great fault forming the eastern face of the Sierra Nevada in California, extending from the southern limit of the Sierras to the elevated region covered by the Lassen Peak volcanic ridge in the northern part of the State. Upon the northwest it merges into the Lassen Peak ridge and the adjacent elevated plateau districts of the Northwestern Intermountain region. Along the northern boundary in Oregon it is separated by an indefinite boundary line extending from the elevated plains of the Northwestern Intermountain region drained by the Columbia River system. Its northern boundary in northeastern Nevada and adjacent portions of Utah and Idaho coincides with the watershed between the Snake River and the Interior Drainage Basin.

The region is characterized by the numerous isolated ridges and mountain ranges, running in a general north and south direction, rising from an arid treeless, desert plain. Most of the streams crossing the plain are of intermittent character and soon disappear in the gravelly and sandy soil or discharge into broad lake basins. Geologically the region is one of widespread complex orographic displacements. The long, narrow ridges and ranges are mainly of monoclinal structure, being formed by upturned edges or tilted blocks of gentle slope upon one side, leading to steep descents by rugged fault scarps upon the other. In certain portions of the province, however, as in central Oregon, frequent masses and cones formed by effusive lava flows or by ejected fragmental material occur. The bases of the desert mountain ranges are deeply buried beneath accumulations of detrital material, forming extensive foot slopes and alluvial fans merging into broad, sloping valleys. The crests of the mountain ridges are usually rugged and barren or occasionally scantily timbered. Associated with the main ranges are occasional mesas and low-lying hills. The elevation ranges from below sea level in Death Valley in California to more than 10,000 feet on the crests of some of the higher ranges.

In certain parts of the region broad, basinlike depressions are encountered, having no outlet and receiving the drainage waters of the surrounding country not previously lost through evaporation and percolation. These basins were in earlier Quaternary times occupied by extensive lakes, remnants of which still

remain. The larger of the extinct lakes are Lake Bonneville in Utah and Lake Lahontan in Nevada, now represented by the Great Salt Lake in the Bonneville Basin and by Carson and other lakes in the Lahontan Basin. The present representatives of the earlier, vastly more extensive bodies of water are subject to considerable fluctuation in extent with varying rainfall, are usually salty or otherwise highly mineralized, and are in many places bordered by marshy areas or by low, barren, salt-encrusted flats.

The exposed rocks of the ranges and hills are mainly of recent effusive and intrusive volcanic character, basalts, rhyolites, diorites, and andesites predominating, with some granitic rocks. Quartzites, with limestones, conglomerates, and other older sedimentary rocks, chiefly of Carboniferous or more ancient age, are of extensive occurrence, particularly in the western and central parts of the region. Some of the more elevated ridges evidence former glaciation which, however, has not influenced the character of the soils.

The Great Basin region is characterized by an arid climate with a large number of clear, sunshiny days. The summers are hot and dry and the winters mild to moderate, with frequent sharp frosty nights and cold periods and bright, warm days. A light to moderate snowfall occurs in the mountains and in the more northern districts. The annual precipitation is unfavorably distributed and is rarely sufficient to grow crops without irrigation, except in certain local low-lying stream valleys or desert lands utilized for the production of wild hay. Water supply for irrigation is generally limited to streams having their sources in the mountains of the Wasatch and Sierra Nevada ranges.

The soils of the region are classified in several province groups according to the agencies contributing to their formation.

Weathering, or disintegration and decomposition of the rocks in place, has led to the formation of a widespread variety of soil material, giving rise to the Residual province, the soils of which are confined mainly to the hills and mountains. These soils are often shallow and contain an excessive quantity of rock fragments or areas of rock outcrop, and, owing to topography and their elevated position with respect to sources of water supply, are generally nonirrigable. These conditions render most of the residual soils of the Great Basin region unfit for agriculture and suitable only for grazing. Since the soil surveys of the region have been confined to the more important agricultural districts none of the soils of the residual province have as yet been encountered.

In the vicinity of extinct volcanic vents or craters local deposits of ejected rock fragments occur, sometimes sufficient in amount to obscure the older surface or to modify material of previous deposition. In one area surveyed the soils formed through this agency have been recognized as a distinct series. It is of limited extent and little agricultural importance under present conditions, although capable of development.

The streams entering the desert valleys are usually of torrential character and many carry water only during the rainy season or at infrequent intervals. The waters are usually absorbed upon reaching the lower, porous, arid slopes, the débris swept from the mountain slopes and upper canyonlike valleys traversed by the stream being deposited as stream outwash and valley filling material. This forms alluvial fans, foot slopes, and débris aprons, progressively building outward, gradually filling the desert valleys and often completely burying the mountain bases and lower ridges. The soils derived from this material constitute another distinct soil province, although they often merge into types of other series in a confusing manner, making separation under field conditions more or less arbitrary. These soils, therefore, as mapped, include more or less undifferentiated material of other series.

In other portions of the Great Basin region there are extensive areas of lacustrine deposits. These are recognized in the classification of the soils of the region as constituting a separate soil province.

In the vicinity of the larger streams extensive recent deposits are encountered. These have been laid down by the streams and occupy the immediate flood plains or terraces lying above them. The materials are sometimes derived in part from adjacent lacustrine deposits and sometimes from the adjacent higher mountain areas. The soils of this character constitute the River Flood Plain province.

Where favorably situated with regard to water supply and where the topography insures adequate drainage and favors irrigation, the soils of the Great Basin region are productive. They are adapted to a wide range of staple and of special crops. Owing to limited water supply, however, the greater pro-

portion of the Great Basin region is incapable of other agricultural use than grazing in certain areas or during certain seasons of the year.

The soils recognized within the region vary widely in texture and structure. Their present use and future adaptation depend more or less upon these physical factors and upon local conditions of climate, topography, facilities for irrigation, and location with respect to markets. With the development of transportation facilities certain areas now devoted mainly to general farming should become capable of more efficient and economical utilization for sugar beets, fruits, or other intensively cultivated products.

The region includes the most extensive areas within the United States which typify or approach true desert conditions. It also embraces the oldest and some of the most highly and successfully developed irrigated districts of the western States.

The area of the different soil groups so far mapped in the Great Basin region, arranged according to the class of material from which they are derived, is given in the following table:

Class of material.	Acres.
Volcanic	4,032
Alluvial fan and valley filling	404,402
Lake-laid	282,618
River flood plain	376,456
Miscellaneous	43,564
Total	1,111,072

VOLCANIC MATERIAL.

The material included under this head gives the only residual soil so far mapped in the Great Basin region. It consists predominantly of fragmental volcanic débris. Material of this character has been encountered in only one survey and, though of unusual character, it is of limited extent. It occurs as slopes of low, broad crater cones, occupying an isolated position upon the desert plains within the Lahontan Basin. While the surface material consists mainly of ejecta of basaltic character, consisting of scoriaceous lapilli, fragments of volcanic bombs and volcanic dust, the deeper underlying material is composed of sediments of the Lahontan Lake beds. In parts of the area the superficial deposits have been mingled with the lake-laid material and the soils pass into lake-laid types by insensible gradations.

The surface slope is generally regular and not excessive and is favorable to irrigation. The water supply is restricted, and only portions of the area covered can be irrigated from a gravity system. A pumping system having its source of supply in near-by canals will be necessary for the higher slopes. This method of irrigation is expensive and practicable only in the production of crops of high market value. Drainage is thorough and the use of a large quantity of water will be necessary.

The soils derived from this residual material are represented only by Soda Lake sand.

DESCRIPTION OF THE SOIL SERIES.

Soda Lake series.—The soils of the Soda Lake series are of gray color and of rather compact structure. They vary in depth from 18 inches to 6 or more feet and are characterized by the occurrence of small angular fragments of scoriaceous basalt of the size of coarse sand and fine gravel. When less than 6 feet deep they are underlain by fine gravelly sand, which sometimes grades into light colored, compact loams at approximately 4 feet below the surface. The series occurs upon the sloping sides of volcanic crater cones in desert plains or valleys. The surface varies from uniform to irregular in character, sometimes being too rough for cultivation. Drainage is excellent. The members of the series are derived from an intermingling of lapilli and other ejected fragmentary products with earlier lacustrine deposits of extinct Quaternary lakes. The volcanic material has been weathered to some extent since accumulation. The surface material is mainly volcanic.

Area and distribution of the soil of the Soda Lake series.

Soil name.	State or area.[1]	Acres.
Soda Lake sand	Nevada 1	4,032

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

The sand member of the Soda Lake series is the only representative of soils of fragmental volcanic material thus far encountered. It is a conspicuous soil type in the Fallon area, Nevada; it is not, however, of great extent and has been encountered only in this area.

This soil is not used for farming to any extent at the present time. Its favorable natural drainage and freedom from alkali salts make it much superior to many of the adjacent soils of the district in which it occurs. The slopes upon which the type is found are slightly elevated above the adjacent plain and would probably prove less susceptible to frost. The soil is of loose, incoherent character, low in power to retain moisture, and would require frequent irrigation and cultivation. In the more exposed places some danger of injury to young crops from drifting might be anticipated when the native vegetation is removed. The soil is easily cultivated and when once cleared would require only a light and comparatively inexpensive farm equipment.

The type is not adapted to general farming, although alfalfa could be grown under irrigation and might prove the best crop where drifting is likely to occur. The type should prove best suited to fruits and melons and other vegetable products.

Soda Lake sand.—This type consists of 18 inches to 6 feet or more of gray, rather compact sand, with fine, angular fragments of scoriaceous basalt of the size of coarse sand and fine gravel. Where less than 6 feet deep it is underlain by a fine, gravelly sand, which sometimes grades into a light-colored loam at a depth of 4 feet. The type occurs upon high slopes of old volcanic crater cones and merges with gentle slopes into the adjacent desert lands. The surface varies from uniform to irregular, in places being too rough for cultivation. Natural drainage is excellent. The type is derived from the intermingling of lacustrine sediments of Lake Lahontan with lapilli and weathered products of volcanic materials. It is generally free from alkali and is considered a desirable soil.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Soda Lake sand	Nevada 1	4,032

[1] For key to number in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The soils derived from the alluvial fan and valley filling material, embracing the alluvial mountain foot slopes, alluvial fan, and alluvial-filled valley plains, constitute one of the most extensive, widely distributed, and important soil groups of the Great Basin region.

In the greater part of the areas covered the surface is moderately or gently sloping, not excessively stony or gravelly, and has a fairly even surface. Drainage in most cases is well established and the topography is favorable to irrigation and the use of farm machinery. Near the mountains, however, the slopes sometimes become steep and broken, the gravel and stone content is high, and the drainage excessive. The lower areas lying at some distance from the foot of the mountains and merging into the flat, low-lying soils of the River Flood plain or Lake-laid group are often deficient in drainage and subject to

accumulation of drainage or seepage waters from irrigation and to the excessive concentration of alkali salts.

The soils are usually deep and productive, and in the Bonneville and Lahontan Basins consists largely of superficial deposits overlying older stratified deposits of lacustrine origin. They are in many places conveniently located with regard to water supply for irrigation, and under favorable conditions of location, climate, irrigation, drainage, and market facilities are susceptible to a high degree of development.

The soils of this province have been widely encountered and mapped. They are of two series. Of these, the Bingham series is the more extensive and important. They occur most extensively in north-central Utah at the base of the Wasatch range and at the foot of smaller desert ridges.

Other extensive areas of soils of similar derivation have been mapped in the Redfield series. These soils are not as widely distributed as those of the Bingham series, and only the fine sandy loam, loam, and clay loam members have been encountered. They occur in the intermountain valleys of central Utah in the vicinity of the base of the elevated plateaus of the Rocky Mountain region.

DESCRIPTION OF THE SOIL SERIES.

Bingham series.—This series occupies the lower mountain and upper valley slopes and valley terraces or plains. It consists of mountain wash or of torrential or intermittent stream delta cone deposits. The soils are generally treeless except in the immediate vicinity of stream courses. The more elevated are frequently eroded by intermittent stream channels. Drainage is good. The soils are derived principally from eruptive, early sedimentary, and altered sedimentary rocks of all ages and modified by material derived from limestone, granites, shales, slates, etc. They occur as irregular and frequently extensive bodies. Where capable of irrigation these soils are often well adapted to alfalfa, grains, sugar beets, vegetables, small fruits, peaches, and other orchard products.

Area and distribution of the soils of the Bingham series.

Soil name.	State or area.[1]	Acres.
Bingham sand	Utah 2, 5	32,168
fine sand	Utah 5	1,900
gravelly sandy loam	Utah 1, 2, 3, 4	132,112
fine sandy loam	Utah 5	86,400
loam	do	15,400
stony loam	Utah 1, 2, 3, 4, 5	62,222
clay loam	Utah 4	12,100
Total		342,302

[1] For key to numbers in this column see p. 733.

Redfield series.—The soils of this series are formed of alluvial mountain wash, or deposits of intermittent or torrential streams. They are generally treeless, sometimes gravelly and marked by rock outcrop, and frequently cut by washes and intermittent stream channels. The soils are derived primarily from red sandstone modified in places by an admixture of material derived from shales, slates, eruptive rocks, etc., and are typically of vermilion or bright red color. They occur generally as extensive areas, sometimes underlain by gravel. The lower-lying and heavier members of the series are often poorly drained and alkaline.

Area and distribution of the soils of the Redfield series.

Soil name.	State or area.[1]	Acres.
Redfield fine sandy loam	Utah 4	44,200
loam	do	14,100
clay loam	do	3,800
Total		62,100

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils derived from alluvial fan and valley filling material show a wide range in use. Not only are they varied in texture and structure, but the conditions of drainage, topography, and irrigation, as well as of transportation are unusually diversified.

The lighter textured soils occurring under the sand groups are represented by the sand and fine sand of the Bingham series. The sand has been encountered to a much greater extent than the fine sand in the areas surveyed and is of much greater agricultural importance. Both are loose, porous, and incoherent, but in case of the sand the deeper subsoil is generally of heavier texture and more compact structure than the surface material. This fact greatly improves the water-holding capacity of the type and renders it fairly retentive of moisture under cultivation, or under certain natural field conditions giving rise to the formation of a loose pulverulent surface mulch. Owing to this subsoil characteristic the sand has a much wider adaptation to crops than the fine sand. The latter is often wind blown, has a low moisture-retaining power and generally occupies a position above the reach of the present irrigation systems. It would usually require considerable labor to level and prepare the surface for irrigation and intertilled crops would probably be subject to injury by drifting if not protected by windbreaks. The fine sand is not used for farming to any extent at the present time, but if irrigated and protected from winds could be utilized for the production of early truck crops and early stone fruits, and to some extent for alfalfa. The sand is to a much greater extent situated favorably with regard to water supply for irrigation and only small local areas are wind blown. Leveling for irrigation is necessary in certain areas of irregular surface, and in places the surface is quite hilly or rolling. Gravel is of frequent occurrence. Some of the lower lying areas of the sand are subject to the accumulation of seepage waters and alkali and are impaired by a high water table, drainage being less thorough over most of the areas than in the areas of the fine sand. Under irrigation the sand is fairly well adapted to general farm crops and certain areas are dry farmed to grain with fair success. Alfalfa is the principal general farm crop grown under irrigation, although wheat and other cereals are being grown to some extent. Under favorable local conditions the type is more profitably utilized in the production of sugar beets, peaches and other stone fruits, pears, and tomatoes and other truck crops.

Both the sand and fine sand require but light and comparatively inexpensive farm equipment.

No normal sandy loam soils are derived from the materials included under this general head. A gravelly sandy loam is shown under the Bingham series. This is an extensive and widely developed type recognized in the surveys of the Salt Lake, Sevier Valley, Bear River, and Provo areas. The soil and subsoil are open and porous when dry, but moderately coherent and loamy when moist. A variable content of gravel is present, but rarely is the amount sufficient to interfere with cultivation, and angular stone fragments, bowlders, or rock outcrop are rarely present. The soil is friable and mellow under cultivation, is easily tilled, and requires only a light farm equipment. The type generally occupies pronounced slopes near the foot of the mountains. The surface is generally regular, and not steep enough to interfere seriously with the use of farm machinery. A considerable proportion of the soil lies above available sources of water supply for irrigation, but where irrigable the surface favors the distribution of water. Excellent drainage generally exists. The soil usually has little power to retain moisture, and is not well suited to dry farming, although areas of limited extent are devoted to small grain.

The fine sandy loams of both the Bingham and Redfield series are extensive and important types, but are not as widely distributed as the Bingham gravelly sandy loam. They usually occur upon lower lying and less pronounced slopes than the gravelly sandy loam and are more frequently poorly drained and affected with alkali. As a rule the moisture-retaining capacity is higher and under favorable conditions of drainage they are better adapted to general farming and therefore more extensively used for the production of alfalfa, grain, and grass crops. They require a heavier farm equipment, but are of mellow, friable character under favorable conditions of drainage and tillage. Some of the higher lying areas are not irrigable from existing gravity systems, but the types are generally so situated as to be easily irrigated. The fine sandy loam of the Bingham series is the better special-purpose soil; the Redfield type is devoted mainly to general farming.

Loams also occur in both the Bingham and the Redfield series. The topography of these soils is generally gently sloping to flat, the types frequently occurring in depressed areas. Drainage conditions are more frequently poor than in the case of the lighter-textured types. The soils are rather sticky when wet and demand more careful management and heavier teams and implements to maintain good tilth. When well drained they are adapted to general crops and to the later maturing vegetable and fruit crops. The Bingham loam is used to some extent for apples and pears; the Redfield type exclusively for general farming. A stony loam phase of the loam group occurs under the Bingham series. This is extensively developed. It differs materially from the normal loams in topography, drainage, physical characteristics, and relation to agriculture. The surface is often rough, the areas occupying moderately to steeply sloping country adjacent to the mountains. They include considerable material of strictly colluvial origin. The use of farm machinery is in many cases impracticable, as is also irrigation. For these reasons the land is of comparatively little agricultural importance.

Clay loam types, constituting the heaviest soils of this province as yet recognized, occur in both the Bingham and the Redfield series. They are less extensively developed than any other of the soil groups, with the exception of the fine sand. Each of these two types has been encountered in only one area. The soils are heavy, sticky when wet, and require considerable care in cultivation. Heavy farm equipment is essential to the proper handling of such soils. Surface and underdrainage are generally poor. Inadequately drained areas are utilized mainly for pastures, but under favorable conditions of drainage, irrigation, and culture the soils are well adapted to the production of alfalfa and small grain.

SAND GROUP.

Bingham sand.—The soil is light gray to grayish brown and of loose, incoherent character. The subsoil is similar to the surface material in color or of slightly lighter tint, the deeper portion being somewhat heavier in texture and of more compact structure. Water-worn gravel is of frequent occurrence in the higher lying areas. The type is usually well drained, but lower lying bodies of limited extent are apt to suffer from insufficient drainage under irrigation. The type is of alluvial origin, deposited by mountain streams as broad alluvial fan and alluvial plain deposits about mountain foot slopes and over the edge of low, broad areas of the Booneville Basin. The soil material is derived from a variety of rocks of igneous, metamorphic, and sedimentary character, the latter consisting of shale, sandstone, and limestone. The surface is sloping to nearly level or sometimes wind blown and interrupted by terrace lines of steep slopes. Where capable of irrigation and favored by conditions of drainage and climate the type is utilized mainly for the production of alfalfa, tomatoes and other vegetables, and peaches. Plums, prunes, and pears are also grown to some extent.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Bingham sand	Utah 2, 5	32,168

[1] For key to numbers in this column see p. 733.

FINE SAND GROUP.

Bingham fine sand.—The soil of the Bingham fine sand is light gray or grayish brown and contains an excessive amount of sand of the finer grades. The structure is porous and incoherent. The subsoil is similar to the soil material in color, texture, and structure. The type is of alluvial origin and distributed as alluvial outwash fan or alluvial slope material by mountain streams. It occurs in the vicinity of mountain foot slopes and about the margins of broad interior drainage basins. The material is derived from a variety of crystalline, volcanic, metamorphic shale, sandstone, and limestone rocks. The surface is usually wind blown and the type not favorably situated for irrigation. The soil is deficient in organic matter, but where properly cultivated under irrigation is suitable for the production of early truck crops.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Bingham fine sand	Utah 5	1,900

[1] For key to number in this column see p. 733.

Sandy Loam Group.

GRAVELLY SANDY LOAM PHASE.

Bingham gravelly sandy loam.—The type is a dark to drab-colored sandy loam or fine sandy loam of open, porous structure, ranging from 18 inches to 6 feet or more in depth, usually underlain by gravel, bowlders, or rock. It occurs as extensive areas, covering lower mountain slopes, upper valley slopes, and sloping alluvial fans generally lying slightly below areas covered by the Bingham stony loam, which it resembles in origin and mode of formation. Flat, shaly, or well-rounded gravel varying in size from fine fragments to 3 or 4 inches in diameter occur upon the surface or within the 3-foot section. The surface is generally free from rock outcrop or bowlders and is well drained and free from alkali. The type frequently lies above the limits of irrigation and is sometimes dry farmed to grains. Where capable of irrigation, it is generally well adapted to truck crops, orchard and small fruits.

Area and distribution of the gravelly sandy loam.

Soil name.	State or area.[1]	Acres.
Bingham gravelly sandy loam	Utah 1, 2, 3, 4	132,112

[1] For key to numbers in this column see p. 733.

Fine Sandy Loam Group.

Bingham fine sandy loam.—The soil is of gray or grayish-brown color and of porous structure. The subsoil resembles the soil material in color. The upper portion is usually of slightly heavier texture than the surface material, becoming coarser in texture and of more porous structure with depth. Water-worn gravel are of frequent occurrence in both soil and subsoil material in the higher lying areas. The type consists of alluvial fan and foot-slope deposits of mountain streams. It occurs about mountain bases and as deltalike plains about the margins of low, flat drainage or lake basins. The material is derived from a variety of volcanic, crystalline, metamorphic, and sedimentary rocks, the metamorphic rocks with shales, sandstones, and limestones predominating. The lower lying areas are sometimes deficient in drainage under irrigation and subject to the accumulation of alkali salts. Under favorable irrigation, drainage, and climatic conditions the type is adapted to alfalfa, grains, sugar beets, truck crops, and tree fruits. The higher lying areas are particularly esteemed for the production of peaches.

Redfield fine sandy loam.—The type consists of a fine sandy loam 6 feet in depth, derived from the disintegration of red sandstones, sometimes mingled with limestones. It is usually well drained. In some areas the soil contains well-rounded, medium-sized gravel within 3 feet of the surface, which increases in quantity and size in the lower depths. Other areas are underlain by sandstone and limestone rocks outcropping at higher elevations. The type occupies valley floors sloping gently from the mountains, upper bench lands, and elevated, undulating plains. It is adapted to alfalfa and grains where favorably located for irrigation.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Bingham fine sandy loam	Utah 5	86,400
Redfield fine sandy loam	Utah 4	44,200
Total		130,60

[1] For key to numbers in this column see p. 733.

Loam Group.

Bingham loam.—The soil of the Bingham loam is gray to dark gray in color. The subsoil usually resembles the soil material in color and other features although in local areas it is sometimes replaced by sand or clay material. The type consists of alluvial foot slope, fan, or alluvial plain deposits of mountain streams, derived mainly from metamorphic and sedimentary rocks, and distributed about mountain bases and as deltalike deposits about margins of low plains of lacustrine or lake-laid deposits. The surface is sloping to nearly flat and the lower lying areas are poorly drained Under favorable conditions of irrigation, drainage, and climate the type is adapted to grains, alfalfa, apples, and pears.

Redfield loam.—The soil is a vermilion-colored loam, usually of silty texture 4½ to 5 feet deep, underlain by a clay loam or occasionally by a sandy loam or sand subsoil. The type occupies level valley floors. is frequently poorly drained. and contains alkali. It is an excellent soil for general farming where drained and free from alkali.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Bingham loam	Utah 5	15,400
Redfield loam	Utah 4	14,100
Total		29,500

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

Bingham stony loam.—The type consists of a sandy loam or fine sandy loam generally of a dark or drab color and loose, porous structure. from 4 to 6 feet deep, containing gravel, stones, and bowlders and underlain by gravel beds or bowlders or by bedrock substratum which frequently outcrops. It occurs along lower mountain slopes and elevated parts of old alluvial fans, and has a sloping and frequently rough or hilly surface. It is well drained and free from alkali salts. The type has been formed by colluvial mountain wash and sedimentary material deposited by intermittent, shifting streams or mountain torrents, and occupies irregular and sometimes extensive areas. The type has little agricultural value at present, being too stony and usually lying too high for irrigation. Where these conditions can be overcome some of the type might be used in fruit growing.

Area and distribution of the stony loam.

Soil name.	State or area.[1]	Acres.
Bingham stony loam	Utah 1, 2, 3, 4, 5	62,222

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

Bingham clay loam.—The soil is a dark or drab loam, usually 4 feet deep, resting upon a clay loam subsoil. The type is similar to the Bingham gravelly loam in origin and mode of formation, but is composed of finer alluvial and colluvial material, is further removed from the mountains, and occupies lower levels and depressions. Drainage is often poor, and the soil contains considerable alkali, but when drained and free from alkali it proves an excellent soil for general farming.

Redfield clay loam.—The soil consists of a vermilion-red clay 5 feet in depth, resting upon a sandy subsoil. The soil is difficult to till except under proper moisture conditions. The type occupies low, level land, is poorly drained, and contains considerable alkali. It is of little agricultural value except for meadow pasture.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Bingham clay loam	Utah 4	12,100
Redfield clay loam	do	3,800
Total		15,900

[1] For key to number in this column see p. 733.

LAKE-LAID MATERIAL.

Extensive areas of lacustrine sediments and of shore and delta deposits occur in the lower basins of the region formerly covered by waters of Quaternary lakes of the Bonneville and Lahontan types. These deposits were derived from adjacent land areas and represent the decomposition products of the rocks with local additions of volcanic dust. Since deposition they have been exposed to weathering and modified by erosion, by the addition of more recent alluvial material, or by wind-blown deposits. Material of this character in the Lahontan Basin is represented by the soil series of that name. In the Bonneville Basin the corresponding accumulations have to a great extent been buried or obscured by later stream and lake-laid sediments. While intermingled with soil material of other provinces or occurring as undifferentiated areas of lake-laid soils, they have not here as yet been recognized by the soil survey as distinctly lake-laid material.

Along the shores of many of the present lakes or occupying the dry beds of those of intermittent character occur extensive areas of recently formed lacustrine sediments. These are represented in the vicinity of Salt Lake, Utah, by the Salt Lake series and around Carson Lake in Nevada by the Carson series. The soils of these series occupy low, flat positions and are poorly drained. The more extensive and typical areas carry excessive quantities of alkali salts and are not well adapted under present conditions to agriculture.

The most extensive soils derived from lake-laid material, so far recognized, are included in the Salt Lake and Lahontan series.

The soils of the Lahontan series have been encountered only in the Fallon area, Nevada. This series includes a number of types, some of which are fairly extensive. The soils of the Salt Lake series, of which only the sandy loam, loam, and clay loam types have been recognized, have been mapped in the Salt Lake, Bear River, Weber County, and Provo areas, Utah. They cover a somewhat greater area than the Lahontan soils.

The Carson series consists of recent lake-laid deposits formed mainly by erosion of the Lahontan Lake beds of earlier date. They have but moderate extent, occurring in the recently exposed basin of Carson sink, included within the Fallon area, Nevada. The Churchill series is represented by a single member, encountered in the Fallon area. It consists of early deposits forming the Lahontan Lake beds, modified by deposits of calcareous tufaceous material derived from hot springs. It is of limited extent and of little importance.

Where typically developed the lake-laid soils occur in extensive and uniform areas. In the earlier surveys the material and soil types were not separated with as much attention to detail as they would be at the present time. In point of area covered in the surveys the soils of lake-laid origin rank second,

but they are less extensively farmed than either the soils derived from the Alluvial Fan and Valley-Filling material or from the River Flood Plain material, which constitute the two other important soil provinces of the Great Basin region.

DESCRIPTION OF THE SOIL SERIES.

Carson series.—These soils consist of drab to black lake-laid material of compact, adobelike structure, about 6 feet deep, though sometimes underlain at lesser depths by lighter lacustrine sediments. Surface drainage and underdrainage are generally deficient. The soil material is derived from the erosion of eruptive rocks. The types occupy low, flat, recently exposed lake-bed plains. The surface is generally treeless and level to slightly sloping and hummocky. Alkali is present in considerable quantities, although where properly drained alfalfa, barley, and sugar beets can be profitably raised.

Area and distribution of the soils of the Carson series.

Soil name.	State or area.[1]	Acres.
Carson clay loam	Nevada 1	9,344
clay	do	4,288
clay adobe	do	5,760
Total		19,392

[1] For key to number in this column see p. 733.

Churchill series.—This series consists of compact, light-yellowish to dark-colored soils carrying considerable calcareous tufa upon the surface and in the soil at a depth of 6 to 8 inches, where it forms a layer from 1 to 5 inches in thickness. In certain sections the lower portion of the soil is honeycombed in structure. The soils are of lacustrine origin, consisting primarily of Lahontan sediments, subsequently modified by deposits from subaqueous springs, giving origin to the tufa. They occur in treeless desert plains of level to undulating surface. Alkali salts are generally present in large amounts, which, together with the occurrence of a surface hardpan, makes the soils of little agricultural importance.

Area and distribution of the soil of the Churchill series.

Soil name.	State or area.[1]	Acres.
Churchill clay	Nevada 1	1,024

[1] For key to number in this column see p. 733.

Lahontan series.—The soils of this series are of light gray to dark gray or drab color and usually underlain at 18 inches to 6 feet by gravelly sandy loam, gravelly sand, or light gravelly loam, which is in turn underlain at a depth usually below 6 feet by lacustrine clays or by compact fine sandy loam. These soils represent lake-laid material derived mainly from the rocks of adjacent mountain ranges, consisting principally of basalt, trachytes, and rhyolites. They have been subject to more or less modification by the action of waves and currents, and since the subsidence of the waters of the lake by stream erosion and sedimentation and by winds. Volcanic material of dust-like character and fragments of calcareous tufa deposited by subaqueous springs are of occasional occurrence. The heavier members occupy rolling to dissected areas, the lighter members being of slightly rolling to hummocky character and frequently marked by dunes or wind-blown ridges. The native vegetation consists of sage, greasewood, rabbit bush, and other characteristic desert shrubs of the region. The heavier members of the series often carry excessive amounts of alkali salts, and are, owing to difficulty and expense of reclamation, considered as undesirable types. The lighter members are sometimes alkaline, but owing to their more porous character are capable of reclamation and adapted to alfalfa, grains, and, in certain cases, to potatoes, vegetables, and small fruits

Area and distribution of the soils of the Lahontan series.

Soil name.	State or area.[1]	Acres.
Lahontan fine sand	Nevada 1	23,168
sandy loam	do	48,704
stony sandy loam	do	3,328
fine sandy loam	do	8,064
gravelly loam	do	4,096
clay loam	do	6,400
clay	do	8,000
Total		101,760

[1] For key to number in this column see p. 733.

Salt Lake series.—These soils are generally dark in color and underlain by compact, heavy subsoils. They represent lacustrine deposits derived from eruptive, sedimentary, and altered rocks of various ages and are usually without gravel. They occupy low, level plains, frequently with sloughs or lagoons, marking the site of recent lake bottoms. They are generally barren, deficient in drainage, and heavily impregnated with alkali salts. Owing to their low-lying position, imperfect drainage, and high content of alkali salts, they are not adapted to crop production under present conditions. The series is extensive in point of area.

Area and distribution of the soils of the Salt Lake series.

Soil name.	State or area.[1]	Acres.
Salt Lake sandy loam	Utah 1, 5	51,308
loam	Utah 1, 2, 5	19,968
clay loam	Utah 1, 3	89,166
Total		160,442

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils derived from the lake-laid materials of the Great Basin region range in texture from fine sand to clay, the sandy loams and clay loams being the most extensive classes. The topography of the soils is usually favorable to the use of farm machinery. Inadequate drainage and lack of irrigation facilities constitute the most widespread and most serious restrictions upon the use of these soils.

The fine sand group is so far represented by a single type in the Lahontan series. This type includes the areas of coarser shore and delta deposits in the Lahontan lake beds. The surface is usually irregular, is wind blown in exposed situations, and usually requires considerable labor in leveling and preparing the land for irrigation. Where extensive areas are cleared of native vegetation, crops may be injured by the drifting soil. Planting windbreaks is an important step in agricultural improvement. The soil is well adapted to the production of melons, potatoes, and other early truck crops, and small fruits. Owing to the tendency to drift, it can probably be best utilized for such intertilled crops in small tracts interspersed with areas of alfalfa or some other effective cover crop, at least until windbreaks are provided. The soil is not at present extensively farmed. Alfalfa and potatoes are the principal products. Poor drainage is much less frequent than in the case of the heavier types. The soil is, however, loose and porous, and under irrigation much loss of water by seepage will occur, making artificial drainage necessary in the lower lying depressions. The soil is easily cultivated and requires but a light farming equipment.

The sandy loam group of lake-laid soils within the Great Basin region includes types of the Lahontan and the Salt Lake series. In the former the soil and subsoil material is usually open and porous, the surface is level to sloping or rolling, and drainage conditions vary from poor to excellent. In most of the areas surveyed drainage is less satisfactory than in the case of the fine

sand. Alkali in injurious quantities is of widespread occurrence, though under favorable conditions of slope this may be readily removed from the soil by irrigation. Lower lying areas require artificial drainage when placed under irrigation. The surface soil in exposed positions drifts, but the type suffers less in this respect than the fine sand. It is not extensively utilized, although alfalfa, potatoes, and grains are grown to some extent. Under favorable conditions of irrigation and drainage it is well adapted to a light type of farming, with alfalfa and potatoes as important crops. It is well suited to early truck crops, and to small fruits and stone fruits where climatic conditions are favorable. It is easily maintained in a good condition of tilth and requires a light farming equipment. It is not so well suited to grain culture as the soils of heavier texture.

The sandy loam of the Salt Lake series occupies low-lying areas of recently exposed lake bottom in the Weber County and Bear River areas of Utah. Drainage is inadequate, and an excessive alkali content generally occurs. The type is not used for farming, and owing to lack of drainage and irrigation facilities is of but little economic importance. Reclamation by irrigation may be effected in certain favored areas.

A stony sandy loam phase of the group occurs in the Lahontan series in the Fallon area, Nevada. This type is comparatively inextensive. The soil material is less loose and porous than the normal sandy loam of the series. The content of rock fragments and bowlders is high. The coarser material consists to a great extent of colluvial deposits. The type usually occupies pronounced slopes, well elevated above the typical sandy loam or other adjacent types. Some areas are eroded and rough. Drainage conditions are better than in the normal sandy loams, and for this reason the soil is generally free from injurious alkali accumulations. The type is not as yet utilized to any extent for farming, but where the stone content is not excessive and the conditions of topography and irrigation are favorable it is well adapted to the production of fruit and truck crops, as well as to a light type of general farming. The soil does not usually drift, and, except upon the steeper and more stony slopes, will probably prove suitable for the culture of alfalfa and grains.

The fine sandy loam group so far includes only that member of the Lahontan series. It is of more compact character than the sandy loam of the same series, but the surface is sometimes wind blown and requires leveling before irrigation is practicable. Drainage is usually deficient, and the areas frequently contain excessive amounts of alkali. Under favorable conditions of drainage the alkali generally disappears with irrigation. The soil material is moderately sticky when wet and somewhat inclined to puddle and bake if improperly handled. When in good physical condition it is usually friable under cultivation, but requires a somewhat heavier farming equipment and more careful management than the sandy loams. It is not extensively utilized for agriculture at the present time.

The loam group is represented only in the Salt Lake series and is of moderate extent. The type occupies a low-lying position, most of the areas covered being confined to poorly drained flats of recently exposed lake bottom, heavily impregnated with alkali. Such areas are nonagricultural and only to a limited extent suited for grazing. In the Provo area, Utah, however, where drainage conditions are better, the soil is now used for farming to a limited extent, and much of the area could be reclaimed through artificial drainage.

A gravelly loam phase of the loam group of soils, of limited area and occurring under the Lahontan series, departs widely from the normal loams of the province in aspects of drainage and agricultural importance. It occupies areas of good slope, and surface drainage is generally well established. It also includes some eroded areas of rough character, having slopes rather excessive for irrigation except by the contour or furrow systems. The soil is but little utilized at present, although much of the area is irrigable and adapted to general farming and fruit growing.

The clay loam group constitutes one of the most extensive soil groups of lake-laid origin. Types have been recognized in the Carson, Lahontan, and Salt Lake series. The Carson clay loam and Lahontan clay loam have been encountered only in the Fallon area, Nevada, and both are of moderate extent. The clay loam of the Salt Lake series is extensively developed and has been mapped in the Bear River and Salt Lake areas, Utah.

The clay loam of the Lahontan series occupies areas of undulating surface in which small, lower lying flats frequently occur. Much of the type contains injurious amounts of alkali. The better drained portions are devoted mainly

to alfalfa, wheat, and barley. Potatoes are grown to a limited extent, but succeed better upon the well-drained soils of lighter texture. The clay loams of the Carson and Salt Lake series occupy lower lying areas of recently exposed lake bottom, the surface of which is usually flat or gently sloping. Much of the land is impregnated with alkali. Underdrainage is generally deficient and, in the case of the Salt Lake clay loam, surface drainage also. The better drained areas are devoted mainly to alfalfa and grains, the more poorly drained bodies being used as pastures or left idle. Where sufficient fall may be obtained to carry off excess subsoil waters, the excess of salts may be leached from the soil by underdrainage and surface flooding and the land reclaimed.

Where so improved or where favored by natural drainage conditions and by adequate irrigation and cultural practice the clay loams of the province are well suited to general farming and to the culture of sugar beets. The soil is refractory and requires heavy draft animals and farm machinery and careful management in irrigation and tillage operations to maintain good physical conditions. Fruits, mainly apples and pears, are grown to a limited extent in the better drained localities, and under favorable conditions the soils are well adapted to this use. Local climatic conditions are, however, generally less favorable to fruit culture than upon the higher lying types.

The clay group comprises types of the Carson, Churchill, and Lahontan series. They have been encountered only in the survey of the Fallon area, Nevada, lying within the Lahontan Basin. Their area is much smaller than that of the clay loams.

The Carson clay is used in a small way for the production of grains, but any extensive use of the type will depend upon artificial drainage. The other members of the clay group are not at present utilized, are poorly drained, contain alkali, and are undesirable for agriculture. The soils are intractable and will require heavy farming equipment, extremely careful management, and expensive artificial drainage. Much of the areas covered would not warrant the expense necessary to establish an adequate drainage system at the present time. Properly drained, the soils are adapted to grains, grasses, alfalfa, and sugar beets.

A clay adobe phase of the clay group of soils occurs under the Carson series. The soil is dense and refractory, and in cultivation requires a heavy farming equipment and careful management. The drainage is poor and alkali occurs in injurious amounts. In these respects, however, the adobe phase is somewhat better than the normal clays, and a larger proportion of the former is farmed. Barley and alfalfa are the principal crops grown. Where drainage is good and the alkali can be removed the soil is adapted to sugar beets and heavy crops.

Fine Sand Group.

Lahontan fine sand.—This type consists of a light-gray fine sand from 24 inches to 6 feet or more in depth, often carrying a noticeable amount of coarse, sharp sand particles and becoming coarser with depth. Where less than 6 feet in depth it is underlain by fine to coarse gravelly sand or sandy loam. It merges gradually into dune sand or other adjacent types and has a sloping to rolling topography. It is derived from Lake Lahontan sediment, subsequently modified by wave, wind, and stream action. It is usually free from alkali and supports a moderate growth of desert shrubs. Where irrigated, drainage will be required for the lower lying areas. Alfalfa and potatoes have been grown to a limited extent, and the type is believed to be suitable for small fruits and truck crops, but in clearing and subsequent cropping should not be left in large areas without protective covering, owing to the erosive effect of winds.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Lahontan fine sand	Nevada 1	23,168

[1] For key to number in this column see p. 733.

Sandy Loam Group.

Lahontan sandy loam.—This type is a yellowish to gray sandy loam of fine to somewhat coarse texture, from 30 inches to 6 feet or more in depth. Small quantities of fine gravel are sometimes present in the surface 12 inches, and a thin veneer of wind-blown sand forms small dunes over the surface. Where less than 6 feet in depth the soil is underlain by a gravelly sand, which grades into a heavy clay loam as the surrounding types are approached. It occurs as small to extensive bodies occupying low flats or pronounced slope lying well above the general level of adjacent soils or stream valleys. The surface varies from level and poorly drained to uneven or rolling or marked by bluffs in the case of the higher lying bench lands. Alkali salts are of common occurrence, but except in the lower lying bodies of deficient drainage are readily removed under the influence of irrigation and natural drainage. The type is generally adapted to the production of alfalfa, potatoes, truck crops, and in the case of the more elevated areas less subject to frosts and protected by windbreaks to small fruits and orchard crops. Drainage is generally good except over the lower lying areas.

Salt Lake sandy loam.—This type consists of 18 inches to 2 feet of sandy loam, underlain by a fine sand subsoil, or frequently by 6 feet of loam interstratified with beds or lenses of fine sand, fine sandy loam, or light loam. It occupies level plains and recent lake bottoms. The soil is poorly drained, contains an excess of alkali, and is bare of vegetation. For these reasons it has no present agricultural value.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Salt Lake sandy loam	Utah 1, 5	51,308
Lahontan sandy loam	Nevada 1	48,704
Total		100,012

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

Lahontan stony sandy loam.—The Lahontan stony sandy loam consists of a gray, compact sandy loam, 18 inches to 6 feet deep, containing quantities of rough angular rock fragments. The gravel may not occur below 18 inches, where bedrock is sometimes encountered within 2 feet. The gravel consists mainly of vesicular lava with some massive basalt and breccia. It is underlain by bedrock consisting of fractured or calcareous material. It occurs as narrow, irregular areas, usually somewhat elevated above surrounding types. The surface is generally uniform but with pronounced slope. Most of the finer material represents sediments of Lake Lahontan, the coarser material being derived by wash from adjacent mountain slopes, eroded and modified by intermittent streams. The subsoil frequently carries considerable alkali, but the type is usually well drained. It should be adapted to alfalfa, grains, and general farm crops where not too stony or shallow, and in favorable localities possibly to fruits. Care in irrigation will be necessary to prevent erosion.

Area and distribution of the stony sandy loam.

Soil name.	State or area.[1]	Acres.
Lahontan stony sandy loam	Nevada 1	3,328

[1] For key to number in this column see p. 733.

79619—13——35

FINE SANDY LOAM GROUP.

Lahontan fine sandy loam.—This is a fine sandy loam of light-gray color and compact structure from 2 to 6 feet deep. Where less than 6 feet deep it is underlain by a gray, rather coarse sandy loam or by a darker colored coarse sand. At approximately 30 inches a compact layer is encountered varying in thickness from a few inches to 4 feet. The type is of lacustrine origin and has been but little modified since deposition. The surface is sometimes broken by small sand dunes or low mounds of wind-blown material. In other places the type is level and without drainage. It is treeless and marked by the usual desert vegetation. Alkali in injurious amounts is usually present, but once removed by drainage and irrigation alfalfa, grains, small fruits, and vegetables can be grown.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Lahontan fine sandy loam	Nevada 1	8,064

[1] For key to number in this column see p. 733.

LOAM GROUP.

Salt Lake loam.—The type consists of 2 to 3½ feet of loam, generally containing a large amount of fine sand or silt, usually underlain to a depth of 6 feet or more by a fine sand, fine sandy loam, or sandy loam subsoil. It occupies level plains, representing recent lake bottoms, is poorly drained, and contains excessive amounts of alkali. The soil is not adapted to agriculture at present, on account of its low-lying position, imperfect drainage, and high salt content.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
Salt Lake loam	Utah 1, 2, 5	19,968

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

Lahontan gravelly loam.—This type consists of a light-gray loam of fine texture, from 1 foot to 6 feet deep, carrying considerable rounded gravel and rock fragments, which may disappear at any depth below the surface foot. Occasionally a stratum of yellow sandy loam is encountered below 3½ feet. Beds of volcanic ash and diatomaceous earth sometimes occur in higher-lying areas. The type occupies high bench lands usually of uniform surface and pronounced slope, though sometimes eroded and rough in character. The finer material is derived from Lake Lahontan sediments, the coarser material representing colluvial wash from adjacent hill slopes. The soil generally carries considerable quantities of alkali salts, but is favored by good drainage and ready percolation. In favorable locations it should be adapted to alfalfa, potatoes, and possibly to fruit, under a system of furrow irrigation to prevent erosion.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Lahontan gravelly loam	Nevada 1	4,096

[1] For key to number in this column see p. 733.

Clay Loam Group.

Carson clay loam.—This type consists of a compact dark-drab to black, sticky clay loam extending to a depth of 2 to 4 feet, the heavier phases approaching adobe in structure. It is generally underlain by a rather coarse, dark-yellowish sandy loam. The type is of recent lacustrine formation and represents sediments deposited from Carson Lake. The surface varies from level to slightly rolling and hummocky, is generally slightly sloping, the slope being sufficient to carry away surface waters, but underdrainage is poor. Considerable quantities of alkali salts are usually present. The type is largely devoted to the production of wild hay. In reclaimed areas alfalfa yields well and sugar beets could probably be successfully grown.

Lahontan clay loam.—The soil is a gray or grayish-brown clay loam, generally 18 inches in depth but sometimes extending to a depth of 6 feet. Below 18 inches it is usually underlain by a gray, coarse sandy loam, often carrying appreciable quantities of fine, water-worn gravel. In the deeper phases a compact stratum of soil may occur at a depth of 30 inches. The soil material represents lacustrine sediments of Lake Lahontan, slightly modified over wind-drifted areas. The topography is generally rolling with occasional small level areas. The native vegetation consists of greasewood, sage, and rabbit brush. The soil generally carries considerable amounts of alkali salts, but when reclaimed it is adapted to alfalfa, grains, and sugar beets.

Salt Lake clay loam.—This type is a loam relatively high in silt, generally 6 feet or more in depth, and becoming somewhat heavier in texture and structure in the lower portion of the section. The type covers large areas of recent lake bottom. The areas are low, level, and poorly drained, and are frequently marked by the presence of meandering sloughs and stream courses. The soil is generally filled with alkali and is of but little agricultural importance. Small areas are devoted to the production of hay and to grazing.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Salt Lake clay loam	Utah 1, 3	89,166
Carson clay loam	Nevada 1	9,344
Lahontan clay loam	do	6,400
Total		104,910

[1] For key to numbers in this column see p. 733.

Clay Group.

Carson clay.—The type consists of 6 feet or more of a drab to black clay loam, sometimes approaching an adobe in structure. The surface is frequently covered with a thin veneer of 1 or 2 inches of fine sand. The soil material is of recent lacustrine origin. The type occurs upon low, flat, recently exposed lake beds, the natural surface drainage, as well as the movement of water through the soil, being deficient. The soil is generally alkaline and supports only a fair growth of grass, with rarely any shrubs. Under a comprehensive system of artificial drainage the type will become fairly well adapted to the production of alfalfa, grains, and sugar beets, though not at present utilized to any extent.

Churchill clay.—This type consists of 6 feet of compact, light-yellowish to dark-colored clay, carrying numerous fragments of tufa upon the surface. These are also encountered at a depth of 6 to 8 inches as a layer from 1 to 3 inches in thickness. The lower portion of the soil section is often of a honeycombed structure. The type is of lacustrine origin, consisting mainly of Lahontan sediments subsequently modified by deposits from subaqueous springs, giving origin to the tufa. It generally carries large amounts of alkali salts and is of inferior agricultural importance, owing to this cause and to the occurrence of a tufaceous hardpan.

Lahontan clay.—This type consists of a gray to grayish-brown, compact, sticky clay, from 18 inches to 6 feet in depth. It is usually underlain below 18 inches by a very compact, brown, fine sandy loam or a gravelly sand, or by both, in which case the fine sandy loam is seldom more than a foot in thickness. The surface is generally level and unbroken, except by occasional wind-blown

knolls of soil material lodged about desert bushes and shrubs. The type occupies a lower position than the adjacent types from which it receives the drainage of storm waters, giving rise to characteristic "playas" or barren, level mud flats. It generally carries excessive amounts of alkali salts and, owing to difficulties in the way of drainage and reclamation, is considered an undesirable soil for agriculture.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Lahontan clay	Nevada 1	8,000
Carson clay	do	4,288
Churchill clay	do	1,024
Total		13,312

[1] For key to number in this column see p. 733.

CLAY ADOBE PHASE.

Carson clay adobe.—This type consists of a heavy black clay of dense, compact, adobe structure, 6 feet or more in depth. In local areas the immediate surface is sometimes covered by a thin mantle of lighter soil material deposited by flood waters from streams and adjacent higher-lying types. It is subject to considerable variation in color and texture as it merges gradually into surrounding soil types. The surface is generally level, though in some localities marked by stream erosion. It generally carries considerable quantities of alkali salts, and artificial drainage will be necessary to render the soil permanently productive. Alfalfa and barley are the principal crops now grown. Under favorable conditions of irrigation and drainage the type should be suited to alfalfa, grains, and sugar beets.

Area and distribution of the clay adobe.

Soil name.	State or area.[1]	Acres.
Carson clay adobe	Nevada 1	5,760

[1] For key to number in this column see p. 733.

RIVER FLOOD PLAIN MATERIAL.

The River Flood plain material covers only a very small proportion of the area of the Great Plains region. The soils derived from this material are level to gently sloping and thus well adapted to irrigation, for which purpose water is generally available. Owing to these conditions, to the abundance of native grasses, the presence of water for domestic use, and to a convenient supply of wood for fuel, the alluvial areas were generally first chosen in the settlement of the region. They now include a large proportion of the more important agricultural sections to which the soil surveys have generally been confined, and in area mapped are nearly equal to the soils derived from the alluvial fan and valley filling or from the lake-laid material.

The soils have been placed in three series—the Fallon series, encountered in the Fallon area, Nevada, and the Jordan and Elsinore series, occurring in the several areas surveyed in Utah. The Jordan series is the most extensive and important agriculturally.

The alluvial soils often merge into the surrounding soils by indefinite degrees, and as mapped often embrace undifferentiated areas of soils derived from the alluvial fan or other kinds of material. This is particularly the case in the districts embraced within the earlier surveys.

Lower lying areas in the flood plains are more or less subject to overflow and are poorly drained and affected with alkali. The greater proportion of the areas mapped are well drained and used for the production of staple and special crops.

DESCRIPTION OF THE SOIL SERIES.

Elsinore series.—These are light-colored soils, the lighter members being often gravelly and usually of friable, porous structure. The soil material extends to a depth of 4 to 6 feet or more, with but little variation in color, texture, or structure, and is underlain by coarse sand and gravel. They are of alluvial character and derived mainly from sandstone and shale material transported for considerable distances by streams. The series occupies low, level areas in the vicinity of streams. The soils are sometimes poorly drained and subject to accumulation of alkali salts.

Area and distribution of the soils of the Elsinore series.

Soil name.	State or area.[1]	Acres.
Elsinore sand	Utah 4	1,900
fine sandy loam	do	7,800
Total		9,700

[1] For key to number in this column see p. 733.

Fallon series.—These soils are of light-brown to dark-gray color and from 18 inches to 6 feet or more in depth. Where less than 6 feet deep they are underlain usually by stream deposits of lighter and frequently of gravelly character. The surface is often uneven, owing to stream erosion or to the occurrence of wind-blown mounds or ridges, requiring considerable leveling for irrigation. The soils are of recent alluvial origin derived mainly from volcanic material. They occupy low-lying flood plains adjacent to stream channels. They support a growth of cottonwood, willow, and underbrush, and are usually free from alkali. Although sometimes subject to overflow and to a high water table, the alkali areas are readily reclaimed. Alfalfa, grains, and potatoes are the principal crops grown.

Area and distribution of the soils of the Fallon series.

Soil name.	State or area.[1]	Acres.
Fallon fine sandy loam	Nevada 1	2,816
loam	do	6,592
Total		9,408

[1] For key to number in this column see p. 733.

Jordan series.—The soils of this series are usually dark in color, but sometimes light gray or reddish, the heavier, lower lying members being underlain by gray, black, yellow, or red, compact, heavy, and often calcareous subsoils. A gravelly substratum is sometimes encountered. The material consists of stream sediments derived from a variety of rocks consisting of lavas, sandstones, shales, limestones, slates, quartzites, and granites. The soils are not at present subject to extensive modification from further deposition by the streams. The areas are treeless, except in the vicinity of streams and lakes. Drainage is usually good, except in lower lying areas. Some of the lighter members are wind blown. The Jordan soils occur in irregular, frequently extensive areas, and are generally devoted to grains, alfalfa, fruits, and truck crops.

Area and distribution of the soils of the Jordan series.

Soil name.	State or area.[1]	Acres.
Jordan fine sand	Utah 1, 3	9,100
sandy loam	Utah 1	3,264
fine sandy loam	Utah 1, 3	80,236
loam	Utah 1, 2, 3	96,940
clay loam	Utah 1, 2	161,280
clay	Utah 1, 2	6,528
Total		357,348

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils of the river flood plains and river terraces of the Great Basin region range in texture from sand to clay. Most of them belong in the Jordan series, and some of the areas include undifferentiated soils derived from lake-laid or alluvial fan material and valley filling material, which would in more detailed surveys be separated.

The sand group is represented by a single member of the Elsinore series. It has been encountered only in small areas, is coarse, leachy, and porous and generally unproductive. If farmed it would require excessive amounts of irrigation water, which, in view of the inadequate supply, is more effectively used upon the heavier and more productive soil types.

The fine sand group at present includes only one type, the Jordan fine sand. It usually occupies the higher river terraces and is generally well drained and free from alkali. It has a loose, porous structure and a low moisture retaining power, except where underlain by a subsoil of less pervious character. It usually requires frequent irrigation. The type is easily cultivated and requires only a light farming equipment. It is of moderate extent and for this reason one of the less important types. The surface is sometimes wind blown and usually requires leveling in preparing the land for irrigation. Where irrigated, early truck crops can be grown. Sugar beets produce good yields under favorable conditions, but in general the soils of heavier texture are better for this crop. With copious irrigation alfalfa may be grown.

The sandy loam group, also represented by a single member of the Jordan series, usually occupies the higher parts of the flood plains and terraces. It is for the most part well drained and free from excessive accumulations of alkali. Where alkali occurs it can readily be removed. The soil has an open structure and is easily maintained in good tilth with light farming equipment. The deeper subsoil is usually more compact and loamy and the type is retentive of moisture under cultivation. Where suitably located for irrigation the type is well adapted to general farm crops and intensively cultivated products.

The fine sandy loam group includes three types. Of these the Jordan fine sandy loam is most extensively developed. As a rule it is fairly well drained and less subject to alkali conditions than the lower-lying soils of heavier texture. It is easily cultivated and retentive of moisture. A moderately heavy farm equipment is necessary for effective handling. It does not differ much from the sandy loam of the same series in crop adaptation, but covers a greater area and is more extensively farmed.

The fine sandy loam of the Elsinore series occupies low, poorly drained areas, and usually carries excessive quantities of alkali. It is not of great present importance and is utilized mainly for pasture, although capable of reclamation and use for agriculture.

The fine sandy loam of the Fallon series is sometimes subject to overflow. It contains alkali salts in moderate amounts and has good underdrainage. It is utilized mainly for alfalfa and barley, and where well drained is well suited to general farm crops and to late, hardy vegetables. Fruits do better on the more elevated soils, owing to greater danger from local frosts, but with care they can probably be grown on this type for home use. This member of the group is not at present extensively farmed.

The Jordan and the Fallon loams are the sole representatives in the loam group. Large areas of the former are encountered. The loams constitute one of the most extensively developed groups derived from river flood plains material.

The Fallon loam has an irregular surface, is in part subject to overflow, usually supports a growth of cottonwood, willows, and other timber, and requires considerable labor to clear and level for cultivation. The water table lies at shallow depths, but the soil is usually free from alkali. The type is utilized mainly for general farming, to which it is well adapted, except where the water table too closely approaches the surface. Here the deep-rooted crops, such as alfalfa, will not succeed.

The loam of the Jordan series is more level, is usually favorably situated for irrigation, and requires less labor to fit the land for cultivation. The timber growth is less vigorous than on the Fallon soils. Conditions of drainage and alkali content are less favorable in general than in the case of the loam of the Fallon series or the lighter Jordan types. The better-drained areas are productive and extensively farmed.

The loams require a heavier farming equipment than the fine sandy loams, and rather careful management, although they are usually friable and mellow when properly handled. Under irrigation and with good drainage and cultivation they are better suited to heavy farming than the soil groups of lighter texture. They are highly esteemed for the production of sugar beets.

The clay loam and clay groups of soils derived from alluvial materials are represented only by types in the Jordan series.

The clay loam is widely distributed and has been encountered in a number of the areas surveyed in the Bonneville Basin, Utah. It varies widely in texture, structure, character of subsoil, drainage, and agricultural importance over local areas. The surface is usually smooth and favorable to irrigation, but a large proportion of the area mapped is poorly drained and heavily impregnated with alkali. The soil of the better drained areas is usually friable when cultivated, but requires a rather heavy farming equipment and careful management. In utilization and adaptation to crops it is similar to the loam group. The lower poorly drained areas of high alkali content afford some pasturage. Parts of such areas may be reclaimed by artificial drainage.

Much less of the clay has been mapped than of the clay loam, but it occurs in a number of the areas surveyed. The conditions as to drainage and agricultural importance vary widely. The higher lying and better drained bodies are profitably utilized for general farming, but require a heavy farm equipment. The more extensive areas, which usually form low lying, poorly drained, salt-incrusted flats, are of little value as farm land under present conditions.

Sand Group.

Elsinore sand.—This type consists of a light-colored coarse sand of porous structure, generally carrying considerable waterworn gravel and extending to a depth of 6 feet or more. It is usually underlain by gravel beds. The type occurs as recent stream sediments covering narrow areas in the vicinity of stream channels, and is derived principally from sandstone and shale material transported for considerable distances by valley streams. The soil is well drained, but is of little agricultural importance.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Elsinore sand	Utah 4	1,900

[1] For key to number in this column see p. 733.

Fine Sand Group.

Jordan fine sand.—This type consists of a light-colored, loose, incoherent fine sand, usually 6 feet or more in depth and resting upon sandy loam or loam. It usually occurs as small, narrow, or irregular areas, often occupying a somewhat elevated position. The surface is barren and marked by irregularities and drifting dunes. Drainage is good and the soil free from alkali. Ordinarily it is of little agricultural importance.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Jordan fine sand	Utah 1, 3	9,100

[1] For key to numbers in this column see p. 733.

SANDY LOAM GROUP.

Jordan sandy loam.—The soil consists of a fine sandy loam about 12 inches deep, underlain to 5 or 6 feet by a coarse, sandy, loamy subsoil, which in turn is underlain by a fine sandy loam or fine sand. The surface foot is usually quite loose in texture, but below this the material becomes very compact. The type owes its origin to river deposits. The topography is level, the type usually occupying forelands adjacent to the streams and higher than surrounding types. The soil is well drained and free from alkali, and is well adapted to alfalfa, grasses, wheat, and other grain crops. It is an excellent soil for sugar beets when irrigation is practiced.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Jordan sandy loam	Utah 1	3,264

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

Elsinore fine sandy loam.—The soil is a light-colored fine sandy loam, 4 feet deep, underlain by a coarse sandy subsoil, grading into gravel in the lower portion. The type occupies low, level parts of valleys. It is derived from transported river material, is poorly drained, and contains considerable alkali near the surface. At present the type is used only to furnish pasturage.

Fallon fine sandy loam.—This soil consists of a light yellowish or brown slightly micaceous fine sandy loam from 2 to 6 feet deep. A thin veneer of alluvial sand or of heavier soil material is sometimes found on the surface, The soil is underlain by a yellow coarse sandy loam or fine gravelly sand. The topography is somewhat irregular and dissected by erosion. The type lies below the level of the adjacent types and is subject to occasional overflow during periods of excessively high water. It is of alluvial origin, the material being derived from sediments transported considerable distances or from reworked Lahontan material. It sometimes carries moderate amounts of alkali salts, but owing to its porous texture natural underdrainage is good, although the water table sometimes quite closely approaches the surface. Cottonwood, willows, and various vines form dense, impenetrable jungles over much of the type. Alfalfa and barley are the principal crops grown. The type is not adapted to commercial fruits, owing to its low-lying position and consequent danger of frosts.

Jordan fine sandy loam.—This type consists of a medium to fine textured sandy loam from 12 inches to several feet in depth. The subsoil generally consists of 18 inches of loam, underlain by 1 foot of fine sand grading into clay below this depth. The type usually occupies lower valley plains and is an important agricultural soil where well drained and free from alkali.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Jordan fine sandy loam	Utah 1, 3	80,236
Elsinore fine sandy loam	Utah 4	7,800
Fallon fine sandy loam	Nevada 1	2,816
Total		90,852

[1] For key to numbers in this column see p. 733.

Loam Group.

Fallon loam.—The soil consists of 18 inches to 6 feet of dark-gray to nearly black loam, occasionally covered with a thin veneer of alluvial sand. Below 18 inches it may be underlain by a coarse, yellowish sandy loam or a fine gravelly sand, the subsoil showing an irregularity of texture similar to the fine sandy loam member of the series. The type occurs as irregular areas adjacent to stream channels and sometimes occupying former deltas. The surface is more or less eroded, marked by knolls of alluvial or wind-blown sand, and requires considerable leveling for irrigation. Although often marked by a high water table, underdrainage is good owing to the porous texture and structure of the soil. The type is sometimes subject to overflow, and supports a growth of cottonwood, willow, and brush. It is usually free from alkali and is adapted to alfalfa, grains, and potatoes.

Jordan loam.—The soil consists usually of 3 or 4 feet of loam underlain by a clay subsoil. In places the surface to a depth of from 1 to 2½ feet is a fine sandy loam. In the lower portion of the soil section the loam sometimes extends to a depth of 6 feet or more, while layers or lenses of sand often occur in the subsoil. The type occurs as small, isolated bodies covering parts of the lower valley plains, depressions, or bench lands. The lower-lying areas are generally poorly drained and alkaline.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Jordan loam	Utah 1, 2, 3	96,940
Fallon loam	Nevada 1	6,592
Total		103,532

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

Jordan clay loam.—This soil consists of a dark-gray to reddish clay loam about 3 feet deep. The subsoil usually consists of a heavy yellow or red clay loam or clay, or occasionally a sandy loam. The type is often friable, resembling a soil of much lighter texture. It occurs as extensive areas covering lower valley plains or bench lands. The lower-lying areas are often poorly drained, alkaline, and of a compact structure, making cultivation difficult. Alfalfa, grain, and sugar beets are the principal crops.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Jordan clay loam	Utah 1, 2	161,280

[1] For key to numbers in this column see p. 733.

Clay Group.

Jordan clay.—The soil consists of a heavy clay loam or clay about 1 foot deep underlain to a depth of 6 feet or more by a light-yellow tenacious clay. The subsoil is sometimes marked by thin strata or lenses of sand or fine sand. The type occurs upon valley plains extending from the lower limits of the mountain slopes to recent lake bottoms. The more elevated areas are generally well drained and comprise valuable farming lands. The lower-lying areas are generally poorly drained, alkaline, and of but little agricultural importance.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Jordan clay	Utah 1, 2	6,528

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Meadow	Utah 1, 3, 4, 5	25,188
Dunesand	Nevada 1	14,784
Oolitic sand	Utah 2, 3	2,292
Riverwash	Utah 4	1,300
Total		43,564

[1] For key to numbers in this column see p. 733.

Bulletin 96, Bureau of Soils, U. S. Dept. of Agr. Fig. 11.

Key to the Soils of the Great Basin Region.

- Volcanic material
  - Gray soil
    - Gray subsoil
      - Crater cone material
        - Soda Lake
- Alluvial fan and valley filling material
  - Volcanic, metamorphic, shale and sandstone
    - Gray soil
      - Gray subsoil
        - Bingham
  - Sandstone
    - Vermilion soil
      - Vermilion subsoil
        - Redfield
- Lake-laid material
  - Volcanic
    - Gray to drab soil
      - Light gray to drab subsoil
        - Drainage well established
          - Lahontan
    - Drab to black soil
      - Gray to dark subsoil
        - Drainage poorly established
          - Carson
    - Yellowish brown to drab soil
      - No subsoil
        - Calcareous hardpan deposited from hot springs
          - Churchill
  - Volcanic metamorphic, crystaline, shale and sandstone
    - Dark gray to drab soil
      - Gray to drab subsoil
        - Drainage poorly established
          - Salt Lake
- River Flood Plain material
  - Volcanic
    - Light brown to dark gray soil
      - Light brown to gray subsoil
        - Modified by wind action
          - Substratum sand and gravel
            - Fallon
  - Volcanic metamorphic, crystaline, shale and sandstone
    - Gray to drab soil
      - Gray to drab subsoil
        - Drainage well established
          - Jordan
  - Shale and sandstone
    - Gray to grayish brown soil
      - Gray to grayish brown subsoil
        - Elsinore

SOILS OF THE ARID SOUTHWEST REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

The region of the Arid Southwest as recognized for the purposes of soil classification includes those portions of the Southwestern States lying west of the southern extension of the Great Plains region, south of the Rocky Mountain and the Great Basin regions, and east of the southern Pacific Coast region.

It covers the southwestern third of Arizona, a large area in south-central New Mexico, and in northwestern Texas. It also includes a small area in southeastern Nevada near the Colorado River and the southeastern extremity of California.

In northwestern Arizona the region is separated from the elevated plateaus of the Rocky Mountain region by pronounced fault scarps and massive cliffs, while farther south and east it is distinguished from the rugged mountain districts of southeastern Arizona and southwestern New Mexico and from the plateaus and mountains in central and northern New Mexico by less pronounced physiographic features. Its eastern boundary in New Mexico and in the adjacent portion of Texas is formed by the escarpment of the Staked Plains or uneroded high plains included within the Great Plains region. South of this in Texas its eastern limit is defined by the residual prairies. Its southern boundary is marked by the international boundary line. In California it embraces the Colorado desert area, portions of which lie below sea level. Upon the north and west of the Colorado desert it extends to the San Bernardino and San Jacinto Mountains and minor ridges of the Coast Range. West of the Colorado River and in southeastern California and Nevada it includes the district tributary to the Colorado River drainage and merges into the desert plains and ranges of the Great Basin region, from which it is separated by a poorly defined watershed.

The region covered by this province consists predominantly of sandy, gravelly, arid, sloping or flat, treeless desert plains marked by occasional local basinlike depressions. From the desert plains rise frequent low, rounded hills and occasional flat-topped mesas and many isolated, elongated mountain ridges, generally of arid, treeless, and of rough, rocky character, usually of northwesterly-southeasterly trend. Like the ranges of the Great Basin province, the bases of the mountains are partly buried by colluvial and alluvial detrital deposits forming extensive fans and foot-slopes merging into intervening sloping, alluvial filled valleys. But few perennial streams traverse the region, all of which head in the elevated plateaus and mountains of the adjacent Rocky Mountain region. They flow in wide, shallow valleys, which are generally marked by meandering, débris-choked stream courses, and during flood periods are often subject to overflow. In certain localities the stream valleys are constricted by resistant rocks into narrow, gorgelike valleys bordered by steep, rocky bluffs.

The rocks of the mountain ranges where exposed by erosion consist mainly of Pre-Cambrian gneisses or related crystalline rocks and of Tertiary eruptives, although some areas of the older sedimentary and metamorphic rocks occur. The eruptive rocks are chiefly of rhyolitic and andesitic character. The mountains are of low altitude as compared with the higher elevations of the adjoining regions, the higher ranges, however, attaining an altitude of 5,000 to 7,000 feet.

The Southwestern Arid region is characterized by an arid climate with long, hot summers, mild winters, low relative humidity, and long, unbroken periods of sunshine. It is not generally adapted to farming without irrigation, and the most of it supports but sparse vegetation of desert shrubs, grasses, and cacti, poorly suited for grazing. Evaporation of moisture is excessive. Frosts are of frequent occurrence in the most of the region during the cooler months, owing in part to rapid radiation of heat under conditions of extreme aridity and

cloudless skies. Severe freezes are infrequent, except in the more elevated districts, where frosty periods and some snow may occur during the winter months.

The operation of natural soil-forming agencies in the region has given rise to several groups of soils differing in mode of origin, character of original material, topography, distribution, etc. These various soil groups are recognized as distinct soil provinces.

Where underlying rock is exposed or occurs near the surface, the soils are predominantly of residual origin, formed by weathering of the rock in place. They are mainly confined to the mountain ranges and desert ridges, and owing to topographic position and arid rocky character are nonirrigable and of but little agricultural importance, save for grazing purposes in favorable areas. A few of the higher ranges are timbered and subject to sufficient rain and snow fall to favor the grazing industry or permit utilization of the soils for forestry. In the limited areas covered by the soil survey none of the residual soils of the Arid Southwestern region have as yet been encountered.

Upon some of the arid, wind-swept desert plains occur extensive areas of soil material transported and deposited by winds. The soils are usually of loose, porous character, and owing to lack of moisture-retaining capacity and to the limited water supply available for irrigation, are utilized to but a limited extent. Like those of the Residual province, they are of minor agricultural importance and have not as yet been recognized in the restricted areas covered by the soil survey.

Certain portions of the southwestern part of the region, formerly submerged beneath the waters of the sea, have been subject to deposition of marine sediments. While subsequently modified to some extent by erosion, weathering in place, or by winds, the soils derived from such material are now recognized as a distinct class constituting the Coastal Plain province. Other portions of the region were formerly covered by the waters of inclosed lakes, and have been subject to the deposition of lake-laid sediments which have subsequently been elevated or drained and give rise to soils of lacustrine origin.

Transportation and deposition of stream-borne material from the turbid torrential waters of intermittent and often poorly defined, shifting streams, debouching from the mountains, and by gradual shifting along slopes of disintegrated rock material by sheet surface waters during periods of infrequent but often violent storms, has given rise to another class of soil material of prominent occurrence within the region. This material constitutes the alluvial foot slope deposits, alluvial fans, and desert plains of detrital-filled valleys, into which the more pronounced slopes of the fans and foot slopes merge. The soils derived from these deposits are designated as the soils of the Alluvial Fans and Valley Filling material.

In the vicinity of the larger streams, such as the Salt, Gila, Colorado, the Pecos, and the Rio Grande Rivers, which are subject to sudden and extreme floods, occur extensive areas of recent alluvial stream-laid soils occupying stream terraces and flood plains. These soils constitute the soils of the River Flood Plain province.

Water supply for irrigation purposes is mainly limited to the surface waters of the larger streams which are for the greater part now appropriated for irrigation purposes or capable of being utilized for further irrigation development only at a relatively high expense. Underground waters are utilized extensively in local areas favored by artesian flow or in which expense of pumping for irrigation purposes is not prohibitive.

Where the land is capable of irrigation, the climate is generally favorable to agriculture and often to the production of a wide variety of staple farm and fruit or other intensively cultivated products. Grains, alfalfa, apples, peaches, and other stone fruits, table wine and raisin grapes, truck crops, small fruits, almonds, cotton, and the more sensitive subtropical fruits, as dates and citrus products, are grown.

Transportation and marketing facilities are often inadequate. Local market demands of the small cities and towns are soon supplied and freight rates are generally high. In such districts this tends to check the development of the trucking industry or other forms of intensive agriculture except where the crops demanded by distant markets are of such high market value as to bear the cost of transportation.

The following areas of the different soil provinces of the Arid Southwest have been surveyed:

Soil province.	Acres.
Coastal Plain material	94,400
Lake-laid material	564,546
Alluvial Fan and Valley Filling material	468,047
River Flood Plain material	208,875
Miscellaneous material	39,390
Total	1,375,258

COASTAL PLAIN MATERIAL.

The material of the Coastal Plain province in this region is derived from the deposition of sediments transported to the sea by streams, waves or tidal currents. In the areas covered by the soil survey it has been recognized to but a limited extent, being represented only by the Yuma series, where it is restricted to a single soil type. This type has been encountered in the vicinity of the lower Colorado River, and probably represents marine deposits in the waters of an extensive arm of the sea formerly covering this part of the region and now represented by the Gulf of California. These marine sedimentary deposits have been subsequently modified, superficially at least, by winds, streams, surface waters during brief and infrequent periods of heavy rains, and by weathering. The extent to which these modifying agencies have operated is often difficult to determine, and in a more detailed survey some of the material included under this province would doubtless be differentiated as soil material of the other provinces occurring within the region.

The soil material of the province is, in so far as encountered, generally well suited to agriculture under irrigation. It is not as yet extensively utilized, but wherever irrigation is possible its use is being rapidly extended, being limited only by the available water supply and the cost of constructing the necessary facilities for its distribution.

DESCRIPTION OF THE SOIL SERIES.

Yuma series.—The soils are usually rather compact. The subsoil is similar in character to the soil, save that at a depth of 2 to 6 feet a succession of layers is encountered in which the particles are slightly cemented, the binding material being calcium carbonate, nodules of which are also found in the subsoil. They occupy mesa lands and are generally level and well drained. Small dunes may be encountered over areas of finer textured soils. The soil material consists of stratified alluvial stream terrace or lacustrine delta deposits. Nearly all of the mesa soils contain some alkali, but seldom in harmful quantities. They are adapted to citrus fruits, figs, grapes, garden vegetables, melons, etc.

Area and distribution of the soil of the Yuma series.

Soil name.	State or area.[1]	Acres.
Yuma sand	Arizona 3	94,400

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The soils derived from marine deposits or coastal plain material in the Southwest Arid region are, in so far as recognized, confined to the sand of the Yuma series. This material is subject to some variation in texture, ranging from a fine to a coarse sand. It is generally of slightly compact structure and of loamy character when moist. The subsoil material is rather compact and marked by the occurrence of partially cemented lenses or layers or incipient

hardpan. Owing to these characteristics of soil and subsoil material the soil is moderately retentive of moisture under cultivation and can be irrigated with greater economy in the use of water than is usually the case in soils of the sand group in other provinces occurring within the region. The surface contour is usually favorable to irrigation practice, although wind-blown areas require leveling. Drainage is well established and the soil is generally free from injurious quantities of alkali salts. The soil is easily maintained in a favorable condition of tilth and requires only a light and comparatively inexpensive farming equipment.

By means of carefully regulated irrigation alfalfa, forage crops, and other general farm crops may be grown, although the soil is better suited to the production of figs, grapes, melons, citrus, and early stone fruits and truck crops under intensive cultivation.

Sand Group.

Yuma sand.—The soil is a rather compact, coarse to medium, or fine sand, containing sufficient finer material to give it a slightly loamy character. When dry it has the appearance of a sand, but under irrigation it becomes almost a sandy loam. It is underlain at depths of 2 to 6 feet by a succession of layers in which the soil particles are slightly cemented, the binding material being calcium carbonate, nodules of which are also found in the subsoil. The subsoil to a great depth is of the same sandy nature as the surface. This soil is found on mesa lands and is generally level, smooth, and well drained, but where the texture is finer small dunes may be found. Alkali is usually present in the soil, but not in harmful quantities. The soil is adapted to citrus fruits, figs, grapes, garden vegetables, melons, etc.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Yuma sand	Arizona 3	94,400

[1] For key to number in this column see p. 733.

LAKE-LAID MATERIAL.

The soils of lacustrine or lake-laid material are widely distributed. They constitute one of the most extensive and important soil provinces of the areas to which the limited number of soil surveys in this region have been confined. In the areas of Pleistocene lake deposits of the Pecos Valley, N. Mex., they are represented by the soils of the Roswell series, under which have been recognized the sandy loam, fine sandy loam, and loam members. In the depressions of the Colorado Desert in southern California and occupying the southwestern portion of the Arid Southwest region they are represented by the soils of the Imperial series. This series includes a number of recognized members ranging in texture from sand to clay and represents a group of sediments deposited in the waters of an inland sea. The series was probably formed by delta deposits of the Colorado River across the upper arm of the Gulf of California. The lower part of the depression, a considerable part of which lies below sea level, is represented by the Salton Sink.

The soils of the province have been modified to some extent by eolian agencies and by erosion and deposition of later stream-laid material. Much of the original deposits has been obscured by later material of the other soil provinces, into which the lake-laid material merges and from which it is frequently separated with difficulty. Some of the areas included, in which the superficial material has to a large extent been modified by other agencies, would probably now be differentiated under the other soil provinces of the region in more detailed surveys.

The soils usually occupy gently sloping to flat areas of treeless desert plains. The surface is sometimes wind blown or marked by eroded stream channels or remnants of a former shore, terrace lines, or other irregularities. In general the topography is favorable to the distribution of irrigation waters. The lower lying areas, usually occupied by the heavier soil types, are poorly drained and often impregnated with alkali salts.

Where capable of irrigation and adequately drained these soils are adapted to a wide range of crops. They are highly developed and extensively utilized for general farming and for intensively cultivated special products.

DESCRIPTION OF THE SOIL SERIES.

Imperial series.—The soils are generally of light or reddish color, the heavier members being compact and plastic, poorly drained, and impregnated with alkali. Both soil and subsoil in many places contain lime and gypsum in connection with the other soluble salts. The soil material represents old lake-laid sediments, derived mainly from sandstones and shales. Unlike the soils of the Gila series, the Imperial soils are underlain to great depths by heavy sediments of close and more or less impervious nature which in the lighter members may not appear within the depth of 6 feet. The surface is sometimes marked by bluff or shore lines, sloughs, or stream channels, and is usually modified by wind drifting.

Area and distribution of the soils of the Imperial series.

Soil name.	State or area.[1]	Acres.
Imperial sand	California 5	1,792
sandy loam	do	126,656
clay loam	do	341,056
clay	California 5, 6	46,912
Total		516,416

[1] For key to numbers in this column see p. 733.

Roswell series.—The soils are of a light-gray or grayish-brown to reddish-gray color, with compact, impervious subsoils from 4 to 5 feet deep. The series consists of old lacustrine deposits in extinct lakes. The topography is flat or gently sloping, the soils occupying arid, treeless, valley terraces or plains. Drainage is often deficient and the lands subject to the accumulation of seepage waters and alkali salts. Under favorable conditions of irrigation and drainage the soils are adapted to a wide variety of crops, including alfalfa, vegetables, and tree and small fruits.

Area and distribution of the soils of the Roswell series.

Soil name.	State or area.[1]	Acres.
Roswell sandy loam	New Mexico 1	36,310
fine sandy loam	do	9,090
loam	do	2,730
Total		48,130

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The sand group of soils in the areas mapped in this province is represented by the Imperial sand. This is the least extensive of any of the soil types recognized in the province, and has been encountered only in the Imperial area, California. The soil material varies in texture from medium to fine and is generally underlain by heavier, more compact, and much less pervious subsoils, which check excessive subdrainage and improve the moisture-holding capacity of the soil type. The soil is normally well drained and free from injurious accumulations of alkali salts. The type requires only a light farming equipment and is somewhat better adapted to alfalfa, forage crops, or other general farm crops than the ordinary sandy soils. Early stone fruits, table and raisin grapes, melons, early truck crops, and other intensively cultivated products also do well.

The sandy loam group of soils is represented in both the Imperial and Roswell series, being most extensively developed under the former. The subsoils

are heavy and compact and are generally retentive of moisture under cultivation. Both the soil and subsoil material frequently carry a large amount of gypsum and lime, particularly in the sandy loam of the Roswell series.

The soil is easily maintained in a fine, mellow condition, and its cultivation requires only a light farming equipment. The Roswell sandy loam occupies gently sloping or nearly level plains, admirably adapted to the practice of irrigation. The surface of the sandy loam of the Imperial series is generally wind blown and requires leveling. Poor underdrainage, accompanied by the occurrence of alkali salts, is sometimes found, particularly in the Imperial member of the sandy loam group.

The sandy loams of this province are extensively utilized, and where well drained and irrigated have been highly developed to intensive agriculture. They are well adapted to general farm crops and to sugar beets, fruits, truck crops, and other special products. In the Imperial Valley the sandy loam is, however, somewhat inferior to the sand of the same series for the production of early fruit and truck products and is better adapted to general farming.

The fine sandy loam group of this province is represented by the Roswell fine sandy loam, this member of the Imperial series not yet having been recognized. The type requires somewhat more careful management and thorough tillage than the sandy loam of the Roswell series and slightly heavier farming equipment for effective cultivation, but under favorable conditions is of friable, mellow character. Drainage is sometimes poorly established, and injurious concentrations of alkali salts are of frequent occurrence. Under favorable conditions of drainage and irrigation this type is extensively utilized both for the production of general farm crops and of apples, pears, small fruits, sugar beets, the later and hardier vegetables, etc. It constitutes an important soil type of the areas in which it occurs, but is much less extensive than the sandy loam member of the same series.

The loam, like the fine sandy loam, is represented by a single member occurring under the Roswell series, and is not extensively developed. It occupies low, level areas, often poorly drained and subject to the accumulation of alkali salts, due to seepage waters from adjacent higher lying lands. Where favored by natural or artificial drainage the soil is well adapted to general farm and forage crops, sugar beets, and late vegetables. It is not so well suited to fruit products as the lighter textured soils.

The clay loam and clay soils of the province have been encountered only under the Imperial series, the clay loam being much the more extensive. The surface is usually smooth, nearly level, and well adapted to the practice of irrigation. Surface and underdrainage are poorly developed and much of the areas covered is impregnated with mineral salts. The soils are of dense, impervious structure, deficient in organic matter, and hard to handle. They require careful management, thorough cultivation, and a heavy farming equipment. They are, however, capable of being materially improved by drainage and the systematic use of green manures. Owing to their tendency to puddle and assume a hard, close structure, they are not well adapted to pasture. When properly drained and irrigated, grains, grass, and forage crops, such as millet, sorghum, etc., can be grown. They are not adapted to fruit or vegetable products.

Sand Group.

Imperial sand.—The soil consists of medium to rather fine sand about 5 feet deep, underlain by loam or clay. The drainage is usually well established. While the soil is free from harmful accumulations of alkali, the use of excessive quantities of irrigation water causes these salts to rise to the surface from the loam or clay subsoil when they prove injurious to crops. If this feature is controlled the soil is adapted to any of the crops suited to the climate of the region.

Area and distribution of the sand.

Soil name.	State or area.[1]	Acres.
Imperial sand	California 5	1,792

[1] For key to number in this column see p. 733.

SANDY LOAM GROUP.

Imperial sandy loam.—The soil is a fine-grained, sandy loam, 3 feet deep, underlain by clay or loam. The type is formed of the coarsest of the sediments carried by the Colorado River. The surface is irregular and covered with dunes. Where free from excessive alkali the soil is adapted to any crop suited to the southern arid region.

Roswell sandy loam.—The soil is a fine-grained, gray sandy loam 30 inches deep. The subsoil is a gray, light loam, slightly heavier than the soil. The type is derived from lacustrine deposits, and is well drained and generally free from alkali. It occupies high, level valleys and is recognized as the best general farming land of the region in which it occurs.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Imperial sandy loam	California 5	126,656
Roswell sandy loam	New Mexico 1	36,310
Total		162,966

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

Roswell fine sandy loam.—The soil is a heavy, gray fine sandy loam about 12 inches deep. The subsoil is a light loam underlain by clay at a depth of 5 feet. The type occupies level second-bottom land and is derived from lacustrine deposits. It is poorly drained and often contains alkali. Where drained and free from alkali it is considered a good farming soil.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Roswell fine sandy loam	New Mexico 1	9,090

[1] For key to number in this column see p. 733.

LOAM GROUP.

Roswell loam.—The type consists of a loam about 4 feet deep, underlain by a clay loam or clay. It is formed of old lacustrine deposits and occupies low, level bench lands. The soil is naturally poorly drained and contains alkali, but where well drained and free from alkali it is recognized as well adapted to general farm crops.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
Roswell loam	New Mexico 1	2,730

[1] For key to number in this column see p. 733.

CLAY LOAM GROUP.

Imperial clay loam.—The type consists of a fine-grained, sticky, compact clay loam about 5 feet deep, underlain by clay or clay loam. It frequently contains an excessive amount of alkali. Drainage is costly and difficult on account of the close structure of the soil. When free from alkali the type is productive and adapted to most of the crops suited to the climate; but as the soil tends to pack, annual or cultivated crops will prove most profitable.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Imperial clay loam	California 5	341,056

[1] For key to number in this column see p. 733.

CLAY GROUP.

Imperial clay.—This is a heavy clay soil 6 feet or more in depth. It is derived from deposition of the finer sediment, mainly from sedimentary rocks. The surface is usually level, though in places small dunes exist. When dry and in its natural state it cakes and becomes lumpy. In drying after irrigation the soil becomes very hard and cracks, making cultivation difficult. It is often filled with alkali and is but little cultivated. Sorghum and millet do best upon this type.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Imperial clay	California 5, 6	46,912

[1] For key to numbers in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The deposits of the alluvial fans, mountain foot slopes, and plains of the detrital filled-in valleys are probably most extensively developed of any of the various provinces of soil-forming material occurring within the Arid Southwest region. In the comparatively small area covered by the soil survey in this region the soils derived from these deposits have been recognized under the Glendale and Indio series. They cover comparatively extensive areas and embrace a diversity of soil types ranging in texture from sand to clay loam. Of these two soil series the Glendale is the more widely distributed and is represented by the greater number of soil types. The members of the Indio series, so far as encountered, are represented by the types of light texture, and with one exception have been encountered only in one area.

The surface is usually gently sloping and suited to irrigation. Small, irregular, eroded, or wind-blown areas, however, occur, in which preliminary leveling is necessary. The soils generally occupy a position somewhat above the surrounding types of other soil provinces of the region. Much of the soil can not be irrigated by existing gravity systems, and where available artesian waters are used. The supply of stream waters is limited and usually depends upon facilities for storing it for use in irrigation. Large areas of the alluvial fan and valley filling material in the Arid Southwest region are incapable of irrigation and consequently useless for agriculture, except for grazing live stock. Where irrigable, local climatic and drainage conditions are generally favorable to agriculture, and the soils are utilized for general farm and special intensively cultivated products.

The soils of the province are frequently separated from the adjacent soils of the other provinces by poorly defined boundaries, and the soil areas embrace some modified and undifferentiated areas of soils derived from coastal plain, lake-laid, or river flood plain material.

DESCRIPTION OF THE SOIL SERIES.

Glendale series.—The soils range from light gray or grayish brown to dark brown or chocolate in color, and are underlain by gray to light-brown, highly calcareous subsoils. A stratum of water-worn, lime-coated gravel is sometimes encountered beneath the subsoil. The series is derived mainly from quartz-bearing granites or gneisses and from later eruptives, mainly of basaltic character. The soil material consists predominantly of alluvial fan deposits and

alluvial valley filling distributed by torrential desert streams, and of foot-slope deposits derived from adjacent mountain slopes and distributed by sheet surface waters. The soils usually occupy sloping valley floors and mountain foot slopes. The surface varies from even to irregular wind blown or eroded.

Typical desert vegetation constitutes the only natural growth. The soils are usually well drained, but are often deficient in water-holding capacity because of their stony character and porous structure. Where irrigation is possible they can be successfully utilized for a wide range of crops, including grains, alfalfa, forage crops, vegetables, grapes, and citrus fruits.

Area and distribution of the soils of the Glendale series.

Soil name.	State or area.[1]	Acres.
Glendale sand	Arizona 2, 3; California 26	21,888
sandy loam	Arizona 2	10,368
fine sandy loam	Arizona 1	106,906
loam	Arizona 1, 2	33,514
gravelly loam	Arizona 1	51,066
silt loam	Arizona 2	11,648
clay loam	Arizona 1	60,753
Total		296,143

[1] For key to numbers in this column see p. 733.

Indio series.—The soils are light gray to slate colored, porous and micaceous, and underlain by coarser sand. They occupy treeless desert valleys, sloping valley plains, or upper slopes at the foot of mountain ranges. The soils are derived from granitic rock mixed with shales and sandstones, the soil-forming material representing alluvial or colluvial stream wash modified by shore deposits of ancient lakes or bays. The surface is undulating to hilly, broken by intermittent stream channels and drifted by winds. Drainage as a rule is well established, though sometimes deficient over low-lying areas. Where irrigation is possible and drainage satisfactory, melons, sweet potatoes, track, and general farm crops can be grown.

Area and distribution of the soils of the Indio series.

Soil name.	State or area.[1]	Acres.
Indio sand	California 6	50,112
fine sand	do	36,032
fine sandy loam	do	42,432
gravelly loam	California 5	43,328
Total		171,904

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

The sand groups derived from the alluvial fan and valley filling material are represented by the Glendale and Indio sand and by the fine sand of the latter series.

These soils usually occupy a position moderately elevated above the soil groups of heavier texture. They are porous and often incoherent in structure, and underlain by porous subsoils. They require frequent and copious irrigation and are deficient in moisture-retaining capacity. The fine sand is often of somewhat loamy character when moist and is more retentive of moisture under cultivation than the sands.

The surface contour is favorable to the distribution of irrigation water, but is sometimes wind blown where unprotected by vegetation. Some of the higher-lying slopes are rough, eroded, and strewn with bowlders. Drainage as a rule is well established, and the soils are normally free from injurious concentrations of alkali salts, but owing to the permeable character of the subsoils

lower-lying areas of limited extent may become saturated with seepage waters with the development of irrigation.

Where irrigated, the sands and fine sand are capable of producing a wide range of crops, including grains, alfalfa, fruits, and truck products. They are best adapted to a very light type of general farming and to the production of sweet potatoes, melons, early truck crops, and early stone fruits. The soil is easily cultivated and when cleared of desert shrubs and placed under irrigation requires only a light farming equipment.

The sandy loam has been encountered only under the Glendale series. The soil is slightly coherent and loamy when moist, but is of porous structure and is readily permeated by surface water. It is friable when cultivated and more retentive of moisture than the soils of the sand and fine sand groups. Its cultivation requires only a light farming equipment. The surface is usually well adapted to irrigation, but is sometimes eroded or wind blown. Drainage is well established as a rule. The type is better suited to the production of alfalfa, grains, or other general farm crops than the sand and fine sand, and nearly as well suited to the culture of stone fruits, small fruits, melons, or truck crops. At present it is utilized mainly for general farming.

The fine sandy loam group is represented both in the Glendale and the Indio series of soils. The surface is quite frequently eroded or wind blown, particularly in the fine sandy loam of the Indio series, and requires considerable labor in leveling for irrigation. Drainage is fairly well established, but lower-lying areas are more frequently subject to accumulations of seepage water and alkali salts than the lighter-textured soils within the province. The soil material is distinctly coherent and loamy when moist, but is readily maintained in a good tilth under cultivation and is superior in moisture-retaining capacity to the soil groups of lighter texture. Hardpan sometimes restricts the development of the more deeply rooted crops, but where this condition is absent and the soil irrigated and well drained it is adapted to a wide range of staple and special crops and constitutes the best general-farming soil of the province. It is adapted to alfalfa, grains, and other general farm crops, as well as to the commercial culture of small fruits, stone and other tree fruits, cantaloupes, tomatoes, and truck crops. The fine sandy loams require only a moderate farming equipment for effective cultivation. The soils of lighter texture are somewhat better suited to very early stone fruits, tomatoes, or other products grown for early market.

The loam group is represented by the loam of the Glendale series and by a gravelly loam phase occurring in both the Glendale and Indio series of soils.

The loam is of rather close, compact structure, becoming sticky when wet. It puddles readily where poorly drained and improperly handled, and requires a heavier farming equipment and more careful management for the maintenance of favorable conditions of tilth than the lighter-textured soils of the province. Topography and drainage vary widely, portions of the areas covered occupying well-drained mesa lands or elevated terraces, while areas confined to lower valley plains are sometimes poorly drained. The more elevated tracts are frequently traversed by deep, eroded stream channels and marked by rough, steep bluff or terrace lines. The surface is usually well suited to irrigation, though the greater portion of the more elevated areas lies above present irrigation facilities. Where irrigable and well drained, the soil is adapted to general farming and to the later fruits and vegetables. Its range in adaptation to fruit and vegetable products is more restricted than that of the fine sandy loam group.

The gravelly loam of the Glendale series is well drained and free from alkali. That of the Indio series is frequently deficient in drainage, and is sometimes subject to the occurrence of alkali salts in injurious amounts. Lime carbonate hardpan is of occasional occurrence, and the surface is sometimes eroded or irregular in contour. The soils are of less compact structure than that of the normal loam, and under favorable conditions of irrigation, drainage, and climate are adapted to a wider range of fruits and vegetables, including stone fruits, apples, citrus and small fruits, etc. Where not too gravelly, they are also well suited to alfalfa and other general farm crops.

The heavier groups of soils, in so far as recognized, are confined to silt loams and clay loams, both of which are included in the Glendale series. These soils generally occupy lower lying slopes and are much more frequently subject to conditions of deficient drainage and to the occurrence of an excess of mineral salts than the soils of lighter texture occurring within the province. They generally possess a compact structure, become sticky when wet, and puddle and

bake under unfavorable conditions of drainage and cultivation. They require a heavy farming equipment and careful methods of management, but are retentive of moisture if maintained in a condition of good tilth. They are generally utilized for the production of grains, sorghum, alfalfa and other forage crops, and are best adapted to heavy general farming.

Sand Group.

Glendale sand.—The soil is of light gray to grayish brown color and of loose, incoherent, porous structure. The subsoil closely resembles the soil in color, texture, and structure, though the material of the deeper subsoil may sometimes be of finer texture or contain waterworn or subangular gravel. The type consists of alluvial fan and alluvial foot slope deposits, occurring about valley margins and at the base of steep bluffs or hills and on higher terraces. The material is derived from quartz-bearing granitic rocks and basic eruptives distributed by intermittent streams or torrential flood waters. The surface is usually of gentle to pronounced slope. Unprotected areas are wind blown but the surface contour is usually favorable to irrigation. The soil is well drained and free from alkali. It is deficient in organic matter and owing to its porous character possesses a low moisture-retaining capacity and requires copious and frequent irrigation. Where incapable of irrigation it is unutilized, except to a limited extent for grazing. Under irrigation it is devoted mainly to alfalfa and grains, but is better adapted to the production of grapes, early stone fruits, and truck crops.

Indio sand.—The soil consists of a light-gray medium to rather coarse sand of loose, porous structure composed of slightly rounded quartz particles, mingled with micaceous and granitic material. It is usually 6 feet or more in depth and is underlain by coarser material of the same character. The type occurs upon sloping valley plains and covers extensive areas of the higher slopes skirting the mountains. The higher bodies are formed mainly by wash from adjacent mountains, distributed over sloping fans and débris aprons by intermittent streams. The lower lying bodies consist of old beach sands modified by alluvial and colluvial mountain wash. The more elevated areas are generally gravelly, sometimes strewn with bowlders, and are of rough, broken outline. The soil is well drained and free from alkali, but generally lies above the limits of irrigation, and is therefore of no agricultural value.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Indio sand	California 6	50,112
Glendale sand	Arizona 2, 3; California 26	21,888
Total		72,000

[1] For key to numbers in this column see p. 733.

Fine Sand Group.

Indio fine sand.—The soil is a loose, friable, light-gray, micaceous sand, sometimes of a rather heavy, loamy nature varying from 3 to 6 feet in depth and underlain by coarse sand. The type occurs upon lower and intermediate uniformly sloping plains formed by erosion from adjacent mountains. The surface is marked by minor scoriations and wind-formed ridges. With the exception of the lower-lying bodies it is well drained and free from alkali, and is adapted to grains, sweet potatoes, melons, etc.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Indio fine sand	California 6	36,032

[1] For key to number in this column see p. 733.

Sandy Loam Group.

Glendale sandy loam.—The soil is a friable, grayish-brown, rather coarse sandy loam of porous structure, slightly sticky when moist. The humus content is generally low. The subsoil varies little from the soil, but may contain lenses or strata of finer or heavier textured material. The type is derived predominantly from quartz-bearing rocks of granitic character and from eruptives, mainly of basic character, distributed as alluvial fan and alluvial foot-slope deposits by torrential or intermittent streams in time of flood. The surface is nearly level to gently sloping and occasionally marked by minor wind-blown irregularities or traversed by dry channnels of intermittent streams. The soil is easily tilled and is generally well drained and free from injurious accumulations of alkali salts. Under intensive cultivation it is retentive of moisture, and when irrigated is well adapted to the production of stone fruits, small fruits, tomatoes, and other early truck crops. It also produces profitable yields of alfalfa and grains.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Glendale sandy loam	Arizona 2	10,368

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

Glendale fine sandy loam.—The soil consists of a gray to grayish-brown, friable, fine sandy loam. The upper subsoil is similar to the soil, the lower portion being marked by a hardpan layer of calcium carbonate locally known as "caliche." The type is easily cultivated and maintained in good tilth. It occurs as alluvial fan and foot-slope deposits, distributed by intermittent streams and surface run-off during heavy rains. The soil material is derived from igneous rocks, mainly granite, gneiss, and basalt. The type is well drained and usually free from alkali in injurious amounts. Where not underlain at shallow depths by hardpan and capable of irrigation it is adapted to fruits, alfalfa, and moderately early truck crops, including tomatoes and melons. Where favored by climatic conditions, citrus fruits may be grown.

Indio fine sandy loam.—The soil is a slate-colored, friable fine sandy loam of variable texture, micaceous and porous. It ranges from 2½ to 5 feet in depth and is underlain by sandy loam or sand. Extensive areas of the type are found over the lower valley plains. The soil material was probably deposited in the waters of an ancient bay or an arm of the sea and modified by erosion, winds, and intermittent streams. The surface is rather rough and badly wind drifted. The type possesses strong capillarity, and the lower lying bodies are often poorly drained and filled with alkali.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Glendale fine sandy loam	Arizona 1	106,906
Indio fine sandy loam	California 6	42,432
Total		149,338

[1] For key to numbers in this column see p. 733.

Loam Group.

Glendale loam.—The soil is a chocolate-brown or dark-brown loam generally 6 feet or more in depth, of rather compact structure, sticky when wet, and subject to puddling and baking. It is underlain by a heavier loam of compact adobe structure or by a gravelly lime hardpan. The type occurs as extensive soil bodies covering mesa lands, the lower margins of colluvial mountain foot

slopes, or lower sloping valley plains, over which it has been distributed by intermittent streams traversing secondary fans. The surface of the higher areas is often marked by domelike elevations, bluffs, or terrace lines and is thickly strewn with cobbles and gravel or deeply cut by torrential stream channels. The lower-lying areas are sometimes poorly drained and impregnated with alkali. Where capable of irrigation the soil is adapted to fruits and general farm crops.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
Glendale loam	Arizona 1, 2	33,514

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

Glendale gravelly loam.—The soil is gray to grayish brown or brown and contains a large amount of gravel, usually from 10 to 25 per cent, the gravel content being highest in the immediate vicinity of the foot of the mountains. The subsoil is similar to the soil, the gravel content being somewhat higher and occasionally cemented by calcium carbonate into a hardpan. The type consists predominantly of alluvial fan and foot-slope deposits distributed by intermittent, torrential streams and by surface sheet flood waters. It includes a limited amount of colluvial material. The type is well drained and free from accumulations of alkali salts. Where capable of irrigation it is well adapted to the production of fruits.

Indio gravelly loam.—The type consists of a gravelly loam, about 2 feet deep, underlain by clay to a depth of 6 feet or more. In some of the areas the interstitial material becomes quite sandy. The gravel consists of agate, quartz, chert, limestone, granite, obsidian, and indurated clay, varying in size from 1 inch to 5 or 6 inches in diameter. The type represents old beach lines or alluvial cones. In the lighter phases the soils contain little alkali, but elsewhere the alkali content is high. Destructive erosion by mountain floods is frequent, and much of the type lies too high or is too rough for cultivation. Where irrigable and not too alkaline it is suited to fruits and vegetables.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Glendale gravelly loam	Arizona 1	51,066
Indio gravelly loam	California 5	43,328
Total		94,394

[1] For key to numbers in this column see p. 733.

SILT LOAM GROUP.

Glendale silt loam.—The type consists of a brown, fine-textured, heavy silt loam 6 feet or more in depth, becoming sticky when wet and inclined to bake and crack when dry. The type occurs in valleys and along streams, and is generally level except where cut by washes and gullies caused by erosion. The native vegetation is sparse and often absent on wind-swept areas. Both surface and underdrainage is apt to be deficient. Some alkali accumultions occur where irrigation is practiced. The soil is best adapted to alfalfa, wheat, barley, sorghum, Egyptian and Indian corn, and sugar beets.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Glendale silt loam	Arizona 2	11,648

[1] For key to number in this column see p. 733.

Clay Loam Group.

Glendale clay loam.—The soil is a reddish clay loam of dense, impervious structure. The subsoil is similar in color, texture, and structure to the soil material. The type represents fine alluvial stream outwash material from higher soil bodies, distributed by intermittent streams traversing alluvial fans, and occupies the lower valley plains. It is generally adapted to grains, but is rather heavy and compact for alfalfa.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Glendale clay loam	Arizona 1	60,753

[1] For key to number in this column see p. 733.

RIVER FLOOD PLAINS MATERIAL.

The soils of the river flood plains occupy the flood plains and terraces of the stream valleys. They consist of alluvial material, eroded from adjacent mountains and uplands usually lying beyond the boundaries of the Arid Southwest region, transported by streams, generally of perennial flow, and deposited from overflow waters. The parent material of the deposits is derived from a variety of sources, that in the vicinity of the head waters of the streams consisting prevailingly of granite, gneiss, and volcanic rocks. Some of the streams, however, traverse extensive areas of sedimentary rocks, while shale and sandstone material enters extensively into the deposits in certain other areas. Some of the deposits are comparatively old and occupy terraces well elevated above present stream channels, although the province includes extensive areas of recent flood plain deposits occupying wide stream bottoms annually subject to overflow.

The surface of the soils derived from the river flood plain material is usually nearly level or gently sloping and is admirably adapted to the distribution of irrigation water. Local areas of irregular, eroded, or windblown surface occur, requiring leveling, and extensive areas of the more recent soils support dense thickets of willows, brush, and vines, which increase the cost of clearing and preparing the land for irrigation and cultivation. The soils are usually most conveniently situated of any of the region with respect to sources of water supply for irrigation purposes.

Drainage is often poorly established and alkali is present in injurious amounts. Seepage waters accumulate over the lower lying areas from the irrigation of higher lying lands, accompanied at times by destructive overflows unless protected from erosion.

The soils derived from the river flood plain material embrace some of the oldest and most highly developed agricultural districts of the Southwest Arid region. They constitute a large proportion of the total area covered by the soil survey in the region and under favorable circumstances of irrigation, drainage, and freedom from overflow are highly esteemed for agricultural purposes. They have been encountered only under the Gila series, which is of widespread occurrence and includes a large number of recognized soil types, ranging in texture from fine sand to clay.

DESCRIPTION OF THE SOIL SERIES.

Gila series.—The soils of the lighter members are prevailingly of light yellowish-brown, light grayish-brown, or slightly reddish-brown color and of porous structure. The heavier members range in color from brown or chocolate brown to dark gray or black and are of compact structure. Thin layers of heavier or lighter sediments are frequently encountered within the soil section. The subsoils are similar to the surface soil and are generally underlain by a stratum of sand and rounded gravel. The series occupies stream flood plains and second bottoms or recent terraces. The lower lying areas are often subject to overflow, are poorly drained, and sometimes alkaline. The higher lying members of porous structure are well drained. The surface varies from level to irregular, being somewhat eroded or gullied, cut by stream channels, or wind blown. The material is of alluvial origin and in the vicinity of streams frequently supports a heavy growth of willow, cottonwood, mesquite, canaigre, etc.

Area and distribution of the soils of the Gila series.

Soil name.	State or area.[1]	Acres.
Gila fine sand	Arizona 1, 3; California 26; New Mexico 1	31,042
fine sandy loam	Arizona 1, 2, 3	43,794
loam	Arizona 2, 3; California 5, 26	79,232
silt loam	Arizona 3; California 26	12,672
clay loam	do	24,384
clay	Arizona 1, 3	17,751
Total		208,875

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

While the soils of the River Flood plain province in the Southwest Arid region cover extensive areas in the aggregate, the individual soil types are often inextensively developed, and in any single area surveyed only a part of the members recognized under the province have been encountered. All the soils thus far recognized occur under the Gila series.

The fine sand of this series, which constitutes the coarsest grade of material as yet recognized, is widely distributed, having been encountered in three of the areas surveyed. It is of loose, porous, and incoherent character and underlain by a porous substratum. The organic-matter content is low and the moisture-retaining capacity limited. The surface is usually wind blown, except in protected localities, and frequently supports a growth of brush and timber. Considerable labor is generally necessary in clearing the land and leveling it for irrigation. Only a light farming equipment is required. Drainage is generally well established and the soil free from injurious concentrations of alkali salts. Not all of the areas covered are as yet extensively utilized for agricultural purposes, but general farm crops, truck, and fruits are grown to some extent. The soil is well suited to the production of sweet potatoes, early truck crops, stone fruits, and berries. With frequent irrigation it is fairly well adapted to alfalfa and forage crops, but not so well suited to general farming as the soils of heavier texture.

The fine sandy loam is also of fairly widespread occurrence. It is of loose, porous structure, is easily maintained in a friable, mellow condition, and its cultivation requires only a light farming equipment. It is more retentive of moisture than the fine sand and does not drift so readily. The surface is sometimes irregular and usually requires some leveling in preparing the land for irrigation. Drainage is well established, but the type is more frequently subject to the accumulation of seepage waters or to a high water table than is the fine sand, due to greater capillarity. The type is not so well suited to the culture of early fruit and truck crops as the fine sand, but generally produces higher yields and has a wider range of crops. It is well suited to a light type of general farming, the production of alfalfa and forage crops, and the commercial culture of apples, pears, fruits, and vegetables.

The loam is somewhat less porous and pervious than the lighter-textured types, but is usually friable and easily maintained in good tilth. It requires

only a moderate farming equipment for efficient culture. The surface of this type requires less extensive leveling in preparing the land for irrigation than that of the types of lighter texture. The soil is sometimes subject to overflow and drainage is not so well established as in the other types. Where irrigation is possible and drainage ample the soil is well adapted to the production of alfalfa, grains, forage crops, the later tree and small fruits, and vegetables.

The silt loam and clay loam of the province are generally of rather compact structure, inclined to puddle when wet and to bake and crack when dry, particularly the clay loam. A fairly heavy farming equipment and careful management is necessary for the effective cultivation of these soils. Under favorable conditions of moisture and tillage they prove retentive of water and can be irrigated with greater economy than the types of lighter texture. They usually occupy low-lying areas and are frequently poorly drained and subject to overflow. Alfalfa, grains, and forage crops are successfully grown, and where favored by local conditions of drainage and irrigation they are well adapted to the heavier crops. Fruits do best on the higher lying and better drained areas. The later and heavier vegetables can be successfully grown on the silt loam, but the clay loam member is of rather heavy texture and compact structure for such purposes.

The clay generally occurs in low-lying, depressed areas. It is of compact, intractable structure, and is sometimes poorly drained and subject to the accumulation of alkali salts and to overflow. It requires a heavy farming equipment and careful management, but under favorable conditions of cultivation and drainage is capable of being profitably utilized for heavy general farming. It is more restricted in adaptation to farm crops than the fine sandy loam and silt loam types, but does not depart greatly from the clay loam in the purposes for which it may be profitably utilized.

Fine Sand Group.

Gila fine sand.—The type consists of a porous and incoherent fine sand of yellowish to reddish brown color, generally from 3 to 6 feet or more in depth, underlain by coarser river sands and gravels. It occurs along river banks, where it has been deposited by the currents. The surface is wind blown and generally covered with dunes. The vegetation characteristic of the type consists of mesquite, willow, canaigre, yucca, and cottonwood. The soil is often calcareous and frequently contains small quantities of alkali. It is generally well drained and is adapted to truck, fruits, melons, potatoes, and sometimes alfalfa.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Gila fine sand	Arizona 1, 3; California 26; New Mexico 1	31,042

[1] For key to numbers in this column see p. 733.

Fine Sandy Loam Group.

Gila fine sandy loam.—The soil is a loose, friable, porous fine sandy loam of light-gray or reddish-brown color, from 3 to 6 feet or more in depth, and is underlain by coarser sands and gravel. Layers of heavier sediments appear in the subsoil. The type occurs as long and narrow bodies covering low valley plains and stream bottoms. The surface is frequently wind blown, cut by stream channels, and covered with brush or timber growth. The soil possesses high capillarity and is well drained and free from alkali, except in lower-lying areas subject to stream overflow or seepage from higher elevations. It is generally adapted to alfalfa, truck, and fruit crops.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Gila fine sandy loam	Arizona 1, 2, 3	43,794

[1] For key to numbers in this column see p. 733.

Loam Group.

Gila loam.—The soil approaches the texture of a fine to very fine sandy loam, ranging from 3 to 20 feet in depth, and is nearly always underlain by coarser sand or by river gravel. In some areas of shallow soil a stratum of heavier material is found between the surface covering of fine sandy loam and the underlying sand. It is a valley or bottom type, occurring as long, narrow bodies adjacent to streams. The sandy subsoil insures good drainage where there is an outlet for the ground water. The surface is level or slightly ridged by wind drifting and stream erosion. The soil is composed of sediments deposited by annual flood waters. Some areas of this type contain small quantities of alkali. It is a good soil for all crops suitable to the climate, and particularly for alfalfa.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
Gila loam	Arizona 2, 3; California 5, 26	79,232

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

Gila silt loam.—The soil is a gray to brown silt loam, containing considerable clay, from 12 to 30 inches deep, underlain by sand and occasionally by loam or clay. It is a valley or bottom type occupying former river channels, flood plains, or drainage depressions. The type is composed of sediments deposited by overflow waters. Drainage is often deficient and alkaline accumulations numerous, and the type is often subject to overflow. The soil is rich, easily cultivated, and adapted to a variety of crops.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Gila silt loam	Arizona 3; California 26	12,672

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

Gila clay loam.—The soil is a sticky, plastic clay loam of chocolate brown color, containing considerable organic matter and ranging from 3 to 6 feet or more in depth. It is underlain by sand varied at times by minor strata of heavy sediments. It is an extensive type of wide distribution. The surface is generally nearly level and lies above present stream overflow. The soil is fairly well drained, but is frequently filled with alkali.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Gila clay loam	Arizona 3; California 26	24,384

[1] For key to numbers in this column see p. 733.

Clay Group.

Gila clay.—The soil is a dark-brown to black, sticky, plastic clay of compact adobelike structure, from 1 to 3 feet deep, and underlain by sandy loam, fine sand, or fine sandy loam. The soil puddles readily and tends to check and crack on drying. The type is generally level, occupying flood-plain depressions, slough and lagoon bottoms of small extent, and stream beds. In the Salt River Valley it is probably formed largely from the sediments of prehistoric irrigation waters. It is generally subject to overflow, and is frequently poorly drained and filled with alkali.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Gila clay	Arizona 1, 3	17,751

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Conglomerate	New Mexico 1	11,680
Gypsum	do	11,630
Meadow	do	7,940
Rough stony land	Arizona 1, 3	7,884
Riverwash	Arizona 2	256
Total		39,390

[1] For key to numbers in this column see p. 733.

Key to the Soils of the Arid Southwest Region.

- Coastal Plain material
  - Sandstone and shale
    - Reddish brown soil
      - Reddish brown subsoil
        - Yuma
- Lake-laid material
  - Shale and sandstone
    - Gray to light brown soil
      - Gray to light brown subsoil
        - Deeper subsoil compact and impervious
          - Imperial
  - Metamorphic and limestone
    - Light brown to reddish gray soil
      - Light brown to reddish gray subsoil
        - Roswell
- Alluvial fan and valley filling material
  - Granitic and basaltic
    - Gray to dark brown soil
      - Gray to brown subsoil
        - Glendale
  - Granitic
    - Gray to drab soil
      - Gray to drab subsoil
        - Substratum porous
          - Indio
- River Flood Plain material
  - Granitic and volcanic
    - Grayish brown to dark brown soil
      - Grayish brown to dark brown subsoil
        - Gila

SOILS OF THE PACIFIC COAST REGION.

By Macy H. Lapham.

DESCRIPTION OF THE REGION.

The Pacific Coast region as defined in the classification of soils in this bulletin includes those portions of California, Oregon, and Washington, west of the crest of the Cascade, Sierra Nevada, Sierra Madre, and San Jacinto Mountain ranges.

Physiographically it is characterized by a broad structural valley depression extending through the northern two-thirds of California to Puget Sound in Washington, except where interrupted by mountain ranges and lesser ridges, by the eastern slopes of the elevated Cascade and Sierra Nevada Mountains, and by the lower, complex coastal ranges.

The southern portion of the valley trough is represented by the interior valley of California, embracing the San Joaquin and Sacramento Valleys; the northern portion, in Oregon by the Willamette and Rogue River Valleys and in Washington by the Puget Sound and Lower Columbia River Basins. In California it is bordered upon the east by the Sierra Nevada and by the southern extremity of the Cascade Mountains, and in Oregon and Washington by the latter. Upon the west it is in California separated from the Pacific Ocean by the Mount Diablo and less important coast ranges, and in Oregon and Washington by the ranges of the Klamath, Coast, and Olympic systems. It is limited upon the south by comparatively low ranges, where the Sierra Nevada swings to the west and joins the mountains of the coast. In northern California and in the southern half of Oregon it is interrupted by an extensive region covered by ranges embraced within the Klamath Mountain system.

The floor of this structural trough is not greatly elevated above sea level and is of level to undulating or gently rolling character. The main Cordilleran ridge upon the east between its southern extremity and central Washington in places reaches altitudes of 10,000 to more than 14,000 feet above sea level. The Sierran foothills, however, include many areas of moderate slope not incompatible with the development of agriculture. North of central Washington, the Cascades, while extremely rugged, are less elevated, though occasional high peaks occur. Upon the east the lower slopes of the coast ranges are gentle and capable of cultivation, but the higher ridges are often extremely rugged and are best adapted to grazing and to forestry. The Olympic Mountains, lying west of Puget Sound, are the most elevated and rugged of the westernmost mountains, reaching an altitude of 8,000 feet or more. The region covered by the coast ranges includes many stream valleys, some of which are highly developed and of great agricultural importance.

South of the structural valley depression the region consists predominantly of low, rolling hills to high and rugged mountain ranges. These include some minor valleys or basins and are in places separated from the coast by a belt of gently sloping coastal plain country.

The Sierra Nevada Mountains are composed mainly of highly metamorphic schistose rocks, intruded masses of granitic rocks, and later eruptive sheets and masses. The rocks of the Cascade Range are of later date, effusive in origin, and consist predominantly of basaltic and related material. The range is characterized by a series of elevated volcanic cones. In southern California the higher ranges south of the Sierras include extensive masses of granites, while the lower-lying coastal ridges are mainly composed of sedimentary formations. Northward along the coast the ranges consist of sedimentary and altered sedimentary rocks, with local areas of eruptives. The ranges of the Klamath system include extensive areas of schistose altered rocks, with associated sedimentary rocks, and eruptive masses similar in character and mode of occurrence to those of the Sierra Nevada. In Oregon north of the Klamath group and in southern Washington the rocks consist mainly of sandstones and shales, with

extensive areas of later volcanic material. The Olympic Range is characterized by a number of rugged volcanic peaks resting upon a substructure of older rocks of schistose character.

The great downfold or trough inclosed between these ranges has during periods of depression been partially filled with marine sediments. Subsequently much of these deposits has been obliterated.

The climate of this Pacific Coast region presents a startling variety of conditions. Along the northwestern coast there is an annual rainfall of 80 to 100 inches and the country is clothed with a dense, luxuriant forest; at the southern extremity of the Great California Valley and in extreme southern California precipitation along some of the lower desert ridges and plains is almost negligible. Active glaciers along the higher peaks of the Cascade and Sierra Nevada ranges are contrasted with the production of semitropical fruits and the general absence of rainfall, except in the higher elevations, throughout the southern half of the region.

In the northern half of the region the mountains are usually well forested and irrigation is practiced only locally in interior valleys or under unusual conditions. Throughout the southern half the higher mountains are generally forested, as well as the lower ranges adjacent to the coast, but the eastern slopes of the coast ranges have a restricted rainfall and are often of arid, barren character, and irrigation in the interior, as well as in many of the coastal valleys, is necessary to insure the production of crops.

In the mountain and foothill districts or other areas of consolidated rocks atmospheric agencies have brought about disintegration and decomposition of the rocks in place, giving rise to the soils of the Residual group or province. In certain districts of the northwest and of the higher mountains glaciation has resulted in large areas of transported soil material defined as of the Glacial province. The deposition of sediments in shallow lakes and of material transported by winds has formed the soils of the Lake-laid and of the Wind-laid groups, both of which are inextensive and not of great agricultural importance. The deposition of marine sediments in the valley depressions and along the coast and the distribution and assorting of such sediments by the waves and tides and shore currents have given another kind of soil-forming material. Much of this has subsequently been covered by later alluvial deposits. From this marine material, classed as the Coastal Plain and Old Valley Filling, comes another distinct group of soils. Later deposits laid down by streams, many of them intermittent, emerging from mountain canyons, give rise to another province group of soil-forming material. This group has been classed under the head of Alluvial Fan and Valley Filling material, constituting a later valley filling than the material last described, not readily separable from the alluvial fan deposits, but often lacking the distinct physiographic features of the latter. The soils, with those of the preceding group, constitute the greater proportion of the agricultural lands of the region. Another extensive and highly important soil province completes the classification of the soils of the region. This embraces the recent alluvial soils, constituting the bottoms and terraces along the important streams of the Pacific coast country.

The actual extent of the soils surveyed in these several provinces is given in the following table:

Soil province.	Acres.
Residual material	3,799,735
Glacial material	3,554,752
Lake-laid material	147,904
Wind-laid material	27,904
Coastal Plain and Old Valley Filling material	1,647,942
Alluvial Fan and Valley Filling material	3,712,731
River Flood Plain material	2,051,996
Miscellaneous material	947,614
Total	15,890,578

Variation in climate, topography, and transportation conditions has caused wide differences in the state of agricultural development and the character of the farm products. Some of the most extensive areas of undeveloped lands, as well as of intensively cultivated districts, occur within the region. Much of the land in the undeveloped districts is not suitable for agriculture because of

topographic and climatic conditions, but extensive areas of uncleared forest lands and of undeveloped irrigable lands still await agricultural development.

Of the 14,942,964 acres of soil types and phases which have been differentiated, the following table shows the amount and proportion of each grade of material:

Grade.	Acres.	Per cent.
Sand	1,520,074	10.2
Fine sand	207,746	1.3
Sandy loam	3,254,416	21.9
Fine sandy loam	1,437,378	9.6
Loam	2,693,208	18.0
Silt loam	2,899,193	19.4
Clay loam	1,387,593	9.3
Clay	1,543,356	10.3
Total	14,942,964	100.0

RESIDUAL MATERIAL.

The soils arranged under this head are derived directly from the disintegration in place of consolidated rocks, with only such changes in position and such modification as may result from local erosion and such differences in composition and physical state as may result from differences in climatic conditions, parent rocks, and topography.

The general classes of rocks recognized as influencing the soils are: (1) Igneous and metamorphic rocks, including those like granite and schist, which carry a notable quantity of quartz, and those like basalt, andesite diabase, and amphotites, which are characteristically quartz free; and (2) sedimentary rocks, such as shale, sandstone, and limestone, which may contain the same mineral components as the igneous and metamorphic group, but which have passed through profound changes between the igneous and sedimentary state, and for this reason give rise to a group of soils notably different in character and adaptation to agriculture.

Owing to the more or less resistant character of the rocks from which these soils are derived the country occupied is rolling to rough and mountainous in topography.

Under the humid conditions prevailing in the northern part of the region, the soils, where the slope is not too great, may be used for vegetables, fruit, and general farm crops, and for pasture and forest where the surface becomes more broken. In the more arid section the use of the residual soils is determined by the possibility of dry farming or the feasibility of irrigation, which is much less generally practicable than in other provinces.

Where capable of irrigation, certain soils of this province embrace some of the most valuable fruit soils of the Western States.

DESCRIPTION OF THE SOIL SERIES.

Aiken series.—The soils of the Aiken series range in color through various shades of red to dark reddish brown, the surface, owing to accumulations of organic matter, being sometimes dark brown with but little red. Angular to subangular rock fragments, frequently of large size, are numerous. The subsoils are bright red to brick red in color, heavy and compact, and underlain at shallow depths by bedrock. The soils are usually well drained and retentive of moisture, although in places drainage may be excessive. They occupy mountain and foothill slopes or plateaulike uplands, the surface varying from sloping to steep, rough, and broken, with frequent rock outcrops. The soils of the series are of residual origin and derived mainly from basaltic rocks. The timber growth varies from sparse to heavy. The more moderate slopes are used to some extent for hay and grain crops.

Area and distribution of the soils of the Aiken series.

Soil name.	State or area.[1]	Acres.
Aiken silty clay loam	Washington 7	12,032
clay	Oregon 3, 4, 5	97,408
stony clay	Washington 7	26,624
clay adobe	Oregon 4	768
Total		136,832

[1] For key to numbers in this column see p. 733.

Altamont series.—Light-brown to dark-brown soils characterize the Altamont series, the surface frequently assuming a reddish tinge when wet. Angular rock fragments occur on the surface and throughout the soil. The subsoil is a heavy, rather compact, reddish-brown or light-brown clay or clay loam, resting upon bedrock.

This series occupies a hilly to mountainous country, dissected by gulches and ravines, frequently having steep slopes upon which numerous rock outcrops occur. The soils are well drained, but retentive of moisture. The members of this series are residual in origin, being derived from the decomposition of interbedded sandstones and shales. In areas of insufficient rainfall they are practically treeless, but where subject to heavy precipitation they support a good forest growth. Cultivated areas are used largely for hay, although some grain is grown. Where climatic conditions are favorable and local topography permits, they are adapted to forage crops, fruits, and small fruits.

Area and distribution of the soils of the Altamont series.

Soil name.	State or area.[1]	Acres.
Altamont loam	California 9	9,024
clay loam	California 8, 14; Oregon 3	234,496
clay adobe	California 8	11,136
Total		254,656

[1] For key to numbers in this column see p. 733.

Arnold series.—The Arnold series consists of gray, dark-gray, purplish-brown or brown, and sometimes nearly black soils, occupying lower foothill slopes and the margins of valley plains. They are derived from the weathering of andesitic tufas, ash, or breccias. Small waterworn gravel of conglomerate origin is frequently found with a few subangular andesitic cobbles. The subsoils usually consist of heavy, sticky loams, varying in color from yellowish red to light brown or dark brown, resting upon beds of the original soil-forming material. These soils are typically developed in areas of limited extent along the lower foothills of the Sierra Nevada Mountains bordering the San Joaquin and Sacramento Valleys in California, merging into the lower-lying red soils of the San Joaquin series upon the one hand and into the residual soils of the Sierra series upon the other. The deeper soils of the series are generally retentive of moisture and are mainly devoted to the production of grains by dry farming. They occupy the crests, ridges, or slopes of the lower foothills and, owing to variation in color, frequently present a characteristically mottled appearance.

Area and distribution of the soils of the Arnold series.

Soil name.	State or area.[1]	Acres.
Arnold fine sandy loam	California 13	2,240
loam	do	21,504
stony loam	California 18	30,080
clay adobe	California 13	23,296
Total		77,120

[1] For key to numbers in this column see p. 733.

Auburn series.—The soils of the Auburn series are bright red to dark red in color, the subsoils being generally a somewhat deeper red and usually somewhat heavier in texture and more compact. They rest upon a substratum of bedrock, generally encountered at a depth of 6 feet or less. Rock outcrops and rock fragments of various sizes are of frequent occurrence.

The members of the series are of residual origin and derived from diabase, amphibolites, and associated rocks. The topography varies from moderately sloping hillsides to rough, rocky, and dissected foothill and mountain areas. Much of the area included in the survey is too shallow or rough to permit of cultivation or irrigation, but under favorable conditions of topography, depth, climate, and irrigation they constitute important soils for the production of grapes, olives, figs, and citrus and orchard fruits.

Area and distribution of the soils of the Auburn series.

Soil name.	State or area.[1]	Acres.
Auburn loam	California 12	8,512
clay loam	California 18	128,183
Total		136,695

[1] For key to numbers in this column see p. 733.

Brownsboro series.—The soils are yellow to light brown, the color continuing with little variation throughout the subsoil. Rock fragments are common, the surface soil usually being underlain at shallow to moderate depth by bedrock. These soils occupy mountain and foothill slopes or plateaulike uplands, the surface varying from sloping to steep, rough, and broken. The members of the series are of residual origin and derived mainly from basaltic rocks. The more moderate slopes are used to some extent for hay and grain crops.

Area and distribution of the soil of the Brownsboro series.

Soil name.	State or area.[1]	Acres.
Brownsboro coarse sandy loam	Oregon 4	3,136

[1] For key to number in this column see p. 733.

Climax series.—The soils of the Climax series are of black or rarely of dark-brown color and marked adobe structure. The members of the series are well drained, are frequently shallow, and subject to the occurrence of rock outcrop or of angular rock fragments. They occupy moderately steep slopes and ridges, which sometimes become rolling to steep and broken. They are mainly of residual origin. They are derived from basaltic rocks, and are sometimes subject to moderate erosion. At present these soils are used mainly for grazing, but under favorable conditions some of the types are adapted to pears.

Area and distribution of the soil of the Climax series.

Soil name.	State or area.[1]	Acres.
Climax clay adobe	Oregon 4	17,216

[1] For key to number in this column see p. 733.

Daulton series.—The soils of the Daulton series are light brown to reddish brown in color, of shallow depth, and usually carry small amounts of rock fragments. The subsoil differs but little in color from the soil. Outcrops of schists or of quartz lenses are numerous. The heavier members often have an adobe structure and are generally underlain at less than 6 feet by the parent

rock. These soils are of residual origin, derived mainly from schists carrying quartz lenses. They occupy sloping to rolling or rough lower foothills and are of shallow depth. Owing to this fact, their topographic features, and lack of facilities for irrigation they are of minor agricultural importance, except for grazing.

Area and distribution of the soils of the Daulton series.

Soil name.	State or area.[1]	Acres.
Daulton sandy loam	California 11	6,016
loam	California 8	1,280
clay loam	California 11	9,280
stony clay loam	California 8	1,280
clay adobe	California 8, 11	2,176
Total		20,032

[1] For key to numbers in this column see p. 733.

Diablo series.—The soils of the Diablo series are dark brown or very dark gray in color when dry, becoming darker or black when wet. The prevailing color of the subsoil is light brown to yellowish gray. The soils are residual in origin, being derived from the decomposition of calcareous shales and argillaceous limestones, with some sandstones and conglomerate of Tertiary age. They are usually calcareous, and water-worn gravel and shale fragments are generally present. They are underlain by heavy calcareous subsoils, which are usually somewhat lighter in color, and often in texture, than the soil, especially where the underlying rock is within 3 to 5 feet of the surface. They are well drained but retentive of moisture.

The series occupies rolling to hilly country with many steep slopes, and is in places deeply dissected by ravines and marked by landslides. These soils are practically treeless and are dry farmed to hay and grain.

Area and distribution of the soils of the Diablo series.

Soil name.	State or area.[1]	Acres.
Diablo loam	California 2	3,200
clay loam adobe	California 2, 25	44,160
clay adobe	California 8, 25	125,248
Total		172,608

[1] For key to numbers in this column see p. 733.

Melbourne series.—The Melbourne soils are light brown to reddish brown in color, often dark brown in the immediate surface, frequently carrying a large number of soft, fragile shale fragments and iron concretions or pellets of soft character. When wet they are sticky and untractable, but under favorable moisture conditions are easily tilled. They are underlain at 8 to 15 inches by a yellowish-brown or brownish-red clay loam, usually extending to a depth of several feet and resting upon the parent rock, which sometimes approaches within 3 to 5 feet of the surface. Rock outcrops are rare. These soils are residual in origin, derived from interstratified shales and sandstones. They occupy extensive areas of undulating to hilly uplands and are frequently subject to landslides. The topography ranges from hilly and broken to comparatively level. A large portion of the series is too rough to permit the use of farm machinery. Drainage is well established and erosion fairly active. The types are heavily forested over areas of abundant rainfall. Where not too rough or shallow the soils are well adapted to agriculture.

Area and distribution of the soils of the Melbourne series.

Soil name.	State or area.[1]	Acres.
Melbourne sandy loam	California 14	2,240
fine sandy loam	do	4,160
loam	do	5,184
silty clay loam	Washington 5, 7	1,099,456
clay loam adobe	California 14	1,600
clay	Oregon 3	44,608
Total		1,157,248

[1] For key to numbers in this column see p. 733.

Olympic series.—The soils of the Olympic series are light brown to brown with a reddish cast. The subsoils are generally of compact structure and somewhat lighter in color than the soils, ranging from a light reddish brown to yellowish brown or grayish brown, sometimes slightly mottled. They are most frequently of silty texture. Underlying basaltic rock usually occurs at depths of 3 to 25 feet. Angular to subangular or spherically weathered fragments of basaltic rocks frequently occur in both soil and subsoil or scattered over the surface. The members of the series are of residual origin, derived mainly from basaltic rock. They occupy rough, hilly, or mountainous regions in which outcrops of basaltic rock are of frequent occurrence. Drainage is usually well established and in places excessive. Rainfall is often abundant. These soils are generally heavily forested with fir, hemlock, cedar, and spruce. Owing to the rough topography and relatively inaccessible location the soils of the series are cultivated only to a limited extent and are much better left in forest. Comparatively level or plateaulike areas of small extent can occasionally be used for dairying or general farming.

Area and distribution of the soils of the Olympic series.

Soil name.	State or area.[1]	Acres.
Olympic loam	Washington 5, 7	334,336
stony loam	Washington 7	663,040
silt loam	do	39,424
silty clay loam	do	418,048
clay loam	Oregon 4	3,264
stony clay loam	Washington 7	26,368
clay	do	4,352
clay adobe	Oregon 4	23,040
Total		1,511,872

[1] For key to numbers in this column see p. 733.

Sheridan series.—The soils of the Sheridan series are of residual origin derived from the weathering of dark-colored, fine-textured phases of gabbrodiorite and granodiorite rock. A characteristic feature of this rock is its large content of black hornblende and biotite mica, the plates and particles of which give rise to the black color of the soil and subsoil. The series usually occupies the lower valley slopes along foothills, extending into local drainage depressions, where its members may be somewhat modified by alluvial wash. Bedrock is usually encountered at a depth of 3 feet. When adequately drained the soils are adapted to grain, hay, forage crops, and fruit, according to texture and position of the soil.

Area and distribution of the soils of the Sheridan series.

Soil name.	State or area.[1]	Acres.
Sheridan sandy loam	California 18	1,792
coarse sandy loam	California 15	3,392
Total		5,184

[1] For key to numbers in this column see p. 733.

Sierra series.—The soils of the Sierra series are prevailingly light red to deep red, and of somewhat close structure. They are underlain by compact red subsoils which in turn rest upon the parent rocks, sometimes separated from the subsoil by a thin stratum of adobelike material. The soils are frequently very shallow and marked by angular to subangular fragments, abundant rock outcrops, and rough, rocky areas unsuitable for agriculture. They are of residual origin derived from the weathering of granitic rocks. The soils of this series occupy rolling or mountainous foothill districts and usually support a more or less heavy growth of brush and forest trees. They are generally well drained. This series covers large areas of valuable fruit and grazing lands along the western slope and base of the Sierra Nevada Mountains in California.

Area and distribution of the soils of the Sierra series.

Soil name.	State or area.[1]	Acres.
Sierra sandy loam	California 11	7,168
coarse sandy loam	California 11, 18	67,840
sandy loam adobe	California 3	13,376
fine sandy loam	California 11	6,656
loam adobe	California 18	10,944
clay adobe	California 11	448
Total		106,432

[1] For key to numbers in this column see p. 733.

Siskiyou series.—The Siskiyou soils are gray to dark gray in color, sometimes tinged with red, and characterized by the occurrence of fine granitic or quartz and feldspar fragments. They are often shallow and are underlain by a compact red subsoil, usually of heavier texture than the soil, resting upon bedrock. In places the rock immediately underlies the soil. Drainage is usually excessive. The soils are of residual origin and derived from granitic rocks. They occupy moderately steep or rolling to rough and broken mountain slopes and hills. Bowlders and rock outcrop are frequent. The series usually supports a good timber growth. When capable of cultivation and favored by sufficient rainfall, these soils are well adapted to orchard and small fruits.

Area and distribution of the soils of the Siskiyou series.

Soil name.	State or area.[1]	Acres.
Siskiyou sandy loam	California 13	9,344
coarse sandy loam	Oregon 4	12,160
Total		21,504

[1] For key to numbers in this column see p. 733.

Sites series.—The soils of the Sites series are generally light brown in color. The upper subsoils are similar to the soil material in color and texture and are usually calcareous. The deeper subsoils are reddish brown or red and of compact, impervious structure, resting upon a substratum of bedrock, usually at a depth of but a few feet. The soils are of residual origin, derived from sandstone, shaly sandstone, conglomerate, or shales of calcareous character.

They occupy low, rolling foothills and valley slopes and are usually treeless. They are retentive of moisture and utilized mainly for grazing or for grain production without irrigation.

Area and distribution of the soils of the Sites series.

Soil name.	State or area.[1]	Acres.
Sites fine sand	California 14	4,864
sandy loam	California 8, 14; Oregon 4	30,976
fine sandy loam	California 2; Oregon 4	12,352
gravelly fine sandy loam	California 25; Oregon 4	41,792
loam	Oregon 4	1,536
Total		91,520

[1] For key to numbers in this column see p. 733.

Tolo series.—The soils of the Tolo series are light brown to dark brown, carrying numerous rock fragments. The subsoils vary from light brown or reddish brown to red and are underlain by bedrock, often at shallow depths. They are of residual origin, being derived mainly from greenstones, but include locally some colluvial or landslide material. The soils are well drained and frequently subject to erosion. Rock outcrops are numerous. The series occupies moderate to steep, hilly and mountainous areas. Where capable of cultivation the several types are adapted to pears, apples, and grapes.

Area and distribution of the soil of the Tolo series.

Soil name.	State or area.[1]	Acres.
Tolo loam	Oregon 4	87,680

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Fine Sand Group.

The fine sands of the Residual soils, so far as mapped, are represented by a single type occurring within the coastal district of California.

The soil material is incoherent, porous, and nonretentive of moisture. The soil is not extensively utilized for farming, and the yields of grain, to which the cultivated areas are devoted, are unsatisfactory. It is not adapted to orchard crops or other fruits, and is best adapted to the growing of eucalyptus or other suitable forest trees.

It is greatly inferior in agricultural importance to the fine sand groups of the majority of the other soil regions of the Pacific Coast region.

Sites fine sand.—The soil is a loose, incoherent medium to fine sand of dark-red to reddish-brown color. The subsoil is of lighter red color and silty in texture, and is underlain by disintegrated sandstone at depths which vary with the topography. The top soil to a depth of 3 feet contains a considerable quantity of organic matter. The soil is of residual origin and derived from sandstone. This soil produces light crops of grain and is not well suited to vines or orchards.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Sites fine sand	California 14	4,864

[1] For key to number in this column see p. 733.

Sandy Loam Group.

The sandy loams of the Residual soils are widely distributed. So far as encountered they are confined mainly to the semiarid foothill districts adjacent to the interior valley and to the coastal valleys in California. They are subject to considerable local variation in climate and to widespread variation in topography, depth of soil and character of underlying material, forest cover, drainage, erosion, and adaptation to agriculture.

Some of the members of the group are characterized by shallow depth, frequent rock outcrop, and excessive surface drainage, all of which combine to render the soil poor in moisture-retaining power and unsuited to the production of fruits or other deep-rooted crops. Some of these areas are of rough, broken topography and are generally utilized for pasture. Others suitable to the use of farm machinery are extensively devoted to dry-farmed grains and grain hay. The yields of these products vary with local climatic influences, with exposure to fog and moist winds, or to the hot, dry winds of the interior, and with character of the subsoil, moisture-retaining capacity, drainage, etc. The yields are usually rather light and inferior to those of the heavier Residual soils.

Where moisture-holding capacity and local climatic conditions permit, fruits are profitably grown.

In the interior valley of California grapes, olives, figs, and almonds are the most promising fruit crops, although the soils of these districts have not yet been utilized for the culture of these products to any extent. Peaches, apricots, and cherries could also probably be grown. The success of any of these fruits will depend largely upon the depth and character of the subsoil and the extent to which moisture may be retained by cultivation. Large areas exist that will never be suitable for extensive planting and are better adapted to grazing or nonagricultural purposes.

In the coastal districts where moisture and other climatic conditions are most favorable, apples, apricots, and dry-wine grapes are successfully grown, although not all members of the group are of sufficient depth or otherwise adapted to these crops.

Only rarely do topography and location permit irrigation, and some of the soils of the group are better suited to the production of eucalyptus or other suitable forest trees than to cultivated crops.

Where capable of successful cultivation the soils of this group are better adapted to the production of grapes and of early orchard and small fruits than to general farm crops.

The soil is friable, easily cultivated, and requires only a light farming equipment, except in rolling or hilly areas.

Daulton sandy loam.—The soil consists of a light-brown to dark-brown fine sandy loam of rather compact structure. The subsoil is light brown to reddish brown and underlain by more or less decomposed rocks of metamorphic, siliceous character. Rock outcrop is of frequent occurrence, and rock fragments of small to large size occur on slopes lying below the outcrop. The type occupies sloping to rolling areas, usually lying below bodies of Rough stony land.

But little of the type is of any considerable agricultural importance, and, owing to the shallow character of the soil and to the frequent steep and rough topography, it is adapted mainly to grazing.

Melbourne sandy loam.—The soil consists of light-brown or dark-gray, sticky, coarse sandy loam, 24 inches deep, underlain by a gray or light-brown heavy sandy loam or sandy adobe extending to a depth of 4 feet, where the deeper subsoil grades into a reddish, coarse sandy clay or loam resting upon a substratum of bedrock. Throughout soil and subsoil are scattered angular fragments of rock. The sharp angular sand and gravel give the soil a tendency to pack. The type is of residual origin and derived from shales. It occupies the lower rolling foothills, is well drained and suited to farming, and is generally devoted to grain and hay.

Sheridan sandy loam.—The soil consists of a black, friable sandy loam of medium texture, varying considerably in depth, the average being about 3 feet, and underlain by crystalline rocks. The type usually occupies the lower valley slopes along foothills and extends into local drainage depressions. The type is of residual origin, resulting from the weathering of dark-colored, fine-textured phases of gabbrodiorite and granodiorite rock. A characteristic feature of this rock is the large proportion of black hornblende and biotite mica which it bears, the plates and particles of which give rise to the black color of the soil. In the low-lying areas the material washed from the slopes has been subsequently

modified by alluvial material. When adequately drained this soil is adapted to grains, hay, forage crops, and fruit.

Sierra sandy loam.—The type consists of a compact, grayish-red to bright-red sandy loam from 2½ to 6 feet deep. The texture varies somewhat and the color becomes lighter as the surrounding types are approached. Small quantities of water-worn gravel are encountered occasionally in the vicinity of intermittent stream courses. Rock outcrop is of common occurrence and the type usually carries angular fragments of feldspar and micaceous material. The soil is of residual origin, derived mainly from the weathering of granitic rock. The topography varies from slightly rolling to rough and broken, the type occurring below areas of Rough stony land in the rolling foothill country, and is often crossed by intermittent stream courses. The type is devoted mainly to grazing and the production of grain under dry-farming methods. The deeper and better-situated bodies could, when irrigated, be used for grapes, figs, olives, alfalfa, and possibly for citrus fruits.

Siskiyou sandy loam.—The soil is a dark-gray to brown sandy loam containing a large percentage of coarse, sharp sand of quartz and granitic material and small, water-worn gravel. The surface few inches are often of a light, sandy character. The subsoil is sticky and plastic, of a reddish color, and somewhat heavier than the soil. The type occupies the crests, sides, or entire surfaces of the lower foothills, is retentive of moisture, and is usually devoted to dry-farmed grains.

Sites sandy loam.—The soil is a light-brown to dull-yellow sandy loam, sometimes tinged with red, from 12 to 30 inches deep, and containing some rounded gravel. On the crests of ridges or on steeper slopes the soil material rests on bedrock. The subsoil on the lower slopes is a reddish-brown, often mottled with yellow and blue, clay loam extending to a depth of 3 to 5 feet and underlain by a thin stratum of yellowish sandy loam carrying fragments of the partially decomposed parent rock. The type occupies low, broken ranges of hills, where drainage is apt to be excessive. It is of residual origin, derived from coarse-grained sandstone and conglomerates. Except where too steep to cultivate, it is dry farmed to grain and hay.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Sites sandy loam	California 8, 14; Oregon 4	30,976
Siskiyou sandy loam	California 13	9,344
Sierra sandy loam	California 11	7,168
Daulton sandy loam	do	6,016
Melbourne sandy loam	California 14	2,240
Sheridan sandy loam	California 18	1,792
Total		57,536

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loam soils in this province have been recognized only in the semiarid districts of the interior valleys in southern Oregon and in California. They are most commonly encountered in the areas derived from granitic or associated quartz-bearing crystalline rocks, although represented in one series derived from basic rocks. They are subject to wide local variation in climatic conditions, depth, frequency of rock outcrop, topography, character of subsoil, or of bedrock substratum, and in moisture-retaining capacity and adaptation to agriculture.

Like the members of the sandy loam group, a large proportion of the soils are shallow, rocky, or marked by precipitous topography, and as a result are excessively drained and not adapted to the production of deep-rooted crops. Where capable of cultivation such areas are utilized for the production of dry-farmed grains and grain hay, but where topographic conditions do not admit of the use of farm machinery, or where drainage is excessive and the soils too thin or deficient in moisture-holding capacity to permit the culture of the shallow-rooted grain crops, the soils are devoted to grazing. Where moisture

conditions are favorable some of the more rocky areas of rough topography are adapted to forestry.

The soils are, however, often valuable for the production of early or delicate fruits by reason of exposure, good drainage, and greater freedom from frosts than lower lying adjacent soils of the other provinces of the Pacific Coast region. With favorable topography and where sufficiently deep and retentive of moisture under intensive cultivation or capable of irrigation the coarse sandy loams of some of the more important areas are used extensively for early cherries, peaches, plums, figs, apricots, and grapes. Some small areas are suited to the culture of citrus fruits, but are not extensively utilized for this purpose. The more elevated districts are better adapted to apples and pears than to stone fruits.

The coarse sandy loams are somewhat more porous and better drained than the soils of the sandy loam group, but where not underlain by subsoils of high moisture-holding capacity are less retentive of moisture. Under favorable conditions they are slightly better adapted to early fruits. They are not usually well adapted to grains, alfalfa, or other general farm crops. They require a light farming equipment except in extensive grain production, and where adapted to fruit culture are capable of supporting a highly developed system of farming in intensively cultivated small tracts.

Brownsboro coarse sandy loam.—The soil is of yellow to light-brown color, of shallow depth, and rests upon a yellow to light-brown subsoil of similar texture. It is of residual origin and derived from basaltic rock. It occupies mountain and foothill slopes or comparatively level plateaulike uplands. The surface is frequently broken by rock outcrop and fragments of basaltic rock. In the areas mapped this soil is of minor agricultural importance, but where of sufficient depth and capable of cultivation it is adapted to hay and grain crops. Drainage is usually excessive.

Sheridan coarse sandy loam.—The type consists of a reddish-brown or grayish coarse sandy loam, from 2 to 6 feet deep, underlain by granitic rock. Sharp, angular gravel and fragments of decomposed granite occur throughout the subsoil and occasionally granite ledges appear at the surface. The lower portions of the type are altered in depth by local alluvial deposits.

Sierra coarse sandy loam.—The soil consists of a light-red to reddish-gray, slightly compact coarse sandy loam, underlain at depths ranging from a few inches to several feet by a dark-red subsoil of heavy, adobe structure, which rests upon the parent rock. Angular, light-colored rock particles the size of fine gravel are found in the surface soil, which is generally plastic when moist and friable when cultivated. The type is derived from the underlying granite rock. It occupies rolling foothills and precipitous mountain slopes and is frequently marked by rounded masses of the outcropping rock. Drainage is well established except over small local areas. Where topography and depth of soil permit, the type is well adapted to citrus fruits, peaches, cherries, plums, and grapes.

Siskiyou coarse sandy loam.—The type consists of a dark-gray coarse sandy loam from 12 to 18 inches deep, containing a large amount of small angular rock fragments and becoming more compact in the subsoil where the color changes to shades of red. The soil is residual, from granite. Much of the type is too rough and hilly for cultivation. Arable areas are adapted to peaches, cherries, and small fruit.

Area and distribution of the coarse sandy loams.

Soil name.	State or area.[1]	Acres.
Sierra coarse sandy loam	California 11, 18	67,840
Siskiyou coarse sandy loam	Oregon 4	12,160
Sheridan coarse sandy loam	California 15	3,392
Brownsboro coarse sandy loam	Oregon 4	3,136
Total		86,528

[1] For key to numbers in this column see p. 733.

SANDY LOAM ADOBE PHASE.

This phase of the sandy loam group includes soils of sandy loam texture characterized by a relatively high clay content and by marked development of the structure peculiar to the adobe soils. These peculiarities render the soils of friable, granular structure when in a favorable moisture condition, but very sticky when wet, and readily puddled and disposed to bake and check upon exposure to hot, dry weather; and unless the granular surface structure be quickly developed under natural conditions or aided by cultivation the soil loses moisture rapidly through evaporation.

The sandy loam adobe phase has in this province been encountered in but one area, and is here confined to one soil series. Owing to its compact structure and the usual granular surface conditions, the soil is much more retentive of moisture than the normal members of the sandy loam group. It is best adapted to the production of small grain, but under favorable conditions of depth, tillage, and irrigation is well suited to fruits. It is somewhat later in warming up than the soils of sandy loam and coarse sandy loam texture and not as well suited to early stone fruits. Citrus fruits do well in favorable situations.

This phase of the sandy loam group requires a rather heavy farming equipment, and careful management in cultivation and irrigation. In crop adaptation this type more closely resembles the soils of the loam and clay loam groups than those of sandy loam group.

Sierra sandy loam adobe.—The soil is a red adobe of compact, close structure, tenacious when wet and checking upon exposure. The subsoil differs but little from the soil. The type is subject to much variation in depth and is underlain by disintegrating granite. The type is adapted to dry farming to grain over the lower and less pronounced slopes and where irrigated or favored by natural moisture conditions gives good results when used for fruits.

Area and distribution of the sandy loam adobe.

Soil name.	State or area.[1]	Acres.
Sierra sandy loam adobe	California 3	13,376

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

The residual soils of the fine sandy loam group, so far as encountered in the soil survey, are confined to the semiarid foothill districts adjacent to the interior valleys and coastal valleys in southern Oregon and in California. In utilization and adaptability to crops they are subject to much the same limitations and controlled by the same local variation in depth, character of underlying material, drainage, topography, climatic environment, etc., as the soils of the sandy loam group and its various phases.

They are often of shallow depth and unsuited to deep-rooted crops, excessively drained, of low moisture-retaining power, and of rough, precipitous topography. Some of the rougher areas, where climatic conditions are favorable, are adapted to forestry. These soils are devoted mainly to grazing, although dry farming to grains is practiced where there is sufficient depth of soil and farm machinery can be used. Near the coast the fine sandy loam of the Melbourne series is successfully utilized for the production of apples, and the deeper, better-drained soils for apricots and grapes. Fruit raising has not been attempted upon the soils of this group to any extent in the interior valleys, but where favored by depth, moisture supply and local climatic features, stone fruits, figs, olives, grapes, citrus fruits, berries, and early vegetables could probably be grown. The fine sandy loams are usually somewhat more retentive of moisture than the soils of sandy loam or coarse sandy loam texture in the same series and under similar conditions are better adapted to grain production or general farming and to fruits without irrigation. On the other hand the coarser textured types are somewhat better for early fruit and small fruit products.

The soils are friable and require only a moderate farming equipment under intensive cultivation. When devoted to extensive cultivation of grains, an expensive and heavy equipment in machinery and draft stock is required.

Arnold fine sandy loam.—The soil is a chocolate-brown, friable, smooth, micaceous fine sandy loam, occasionally containing water-worn gravel. The subsoil is similar to the soil. The type occupies the crests of lower foothills, is easily cultivated, and retentive of moisture. Under irrigation it should prove suitable for the production of orchard fruits, grapes, and vegetables.

Melbourne fine sandy loam.—The soil consists of a reddish-brown, tenacious sandy loam 30 inches deep, underlain by a dark-red sandy loam, finer and heavier in texture than the soil and filled with particles of sandy shale to a depth of 6 feet or more. Occasionally a layer of heavy silty clay loam is encountered at depths of 4 to 6 feet. The sand is sharp and angular, causing the soil to become very hard and compact when dry. In the subsoil it results in the formation of an adobe structure which is often mistaken for hardpan. The type is of residual origin and derived from shales and conglomerate. It is well drained and occupies valley ridges and foothills. Apricots, apples, and American grapes are well adapted to this type.

Sierra fine sandy loam.—The type consists of a compact, bright-red to deep-red fine sandy loam, from 2 to 6 feet deep, containing numerous angular fragments of feldspar. It is underlain by a compact, heavy, bright-red clay loam or partially weathered parent rock. The clay loam subsoil may be entirely absent, and when present is rarely over 24 inches in depth. The surface of the areas occupied by this type is rolling to sharply rolling and marked by courses of small intermittent streams. Rock outcrop is of common occurrence. The type is devoted to grazing or dry farming to grains. When irrigated the deeper and more favorably located areas should prove suitable for the production of grapes, figs, olives, alfalfa, and possibly citrus fruits.

Sites fine sandy loam.—The soil is of a rather light brown color, the subsoil being similar in color and character of material and underlain by bedrock at a depth ranging from a few inches to 6 feet or more. The type is of residual origin from sandstone. It occupies mountain slopes and rolling to dissected foothills. Where sufficiently deep it is adapted to peaches, cherries, grapes, pears, and small fruits.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Sites fine sandy loam	California 2; Oregon 4	12,352
Sierra fine sandy loam	California 11	6,656
Melbourne fine sandy loam	California 14	4,160
Arnold fine sandy loam	California 13	2,240
Total		25,408

[1] For key to numbers in this column see p. 733.

GRAVELLY FINE SANDY LOAM PHASE.

The fine sandy loams of gravelly character in the Residual province are of rare occurrence, having been encountered so far in but one series. This particular type is of undulating to rolling topography and well drained, but not favorably situated for irrigation and rather deficient in its power to hold moisture. It is usually devoted to grazing and to dry farming to grains. Small areas in California are used for the culture of almonds, apricots, and grapes.

Owing to the gravel content, the gravelly fine sandy loams are usually of more porous structure and less retentive of moisture under droughty conditions than the normal fine sandy loams. The former are consequently not so well adapted to grains or fruit crops without irrigation. Where irrigation is practicable or where the natural moisture supply is adequate they are well adapted to peaches, almonds, apricots, and other early stone fruits.

Sites gravelly fine sandy loam.—The surface soil is a light-brown fine sandy loam. The subsoil is similar to the soil in color and texture and is underlain at depths varying from a few inches to 6 or more feet by bedrock. Both soil and subsoil material contain small, water-worn pebbles derived from the parent rock. The type is of residual origin, derived from sandstone and conglomerate. The topography is gently sloping to rolling and the drainage well established. Where of sufficient depth, the type is adapted to the production of apples, pears, and peaches. Much of the type is too shallow to be used for tree fruits or other deep-rooted crops.

Area and distribution of the gravelly fine sandy loam.

Soil name.	State or area.[1]	Acres.
Sites gravelly fine sandy loam	California 25; Oregon 4	41,792

[1] For key to numbers in this column see p. 733.

Loam Group.

The soils of the loam group occur extensively in the Residual province of the Pacific Coast region.

They are subject to the usual wide variations of the soils of the province in conditions of depth, character of subsoil, relation to drainage, moisture supply and erosion, topography, etc., and occur under wider extremes of climate than the soils of the previously noted groups. The greater number of the loam types recognized lie in the foothill districts bordering the interior valley and coastal valleys of California. Some of these, however, are of local occurrence and small extent. Other members of the group occur in the subhumid regions of southern Oregon and western Washington. In these regions the loams of three distinct soil series have been recognized, two of which are fairly extensive.

In the humid, heavily forested districts much of the areas covered by the loams are rough and mountainous, and better adapted to forestry than to farming. The climate, however, favors the production of native grasses, hay, and forage crops, and where the topography is not too rough and broken the soils are adapted to dairying. Fruits and vegetables can be grown for home use, and under favorable conditions in commercial quantities. In Oregon the climatic conditions are less suitable to dairying and to hay, grain, and forage crops than to the culture of orchard fruits. In neither of these districts have the soils been developed to any extent.

In California the loams are usually devoted to grazing and to dry-farmed grain. Conditions are not favorable for dairying, except when alfalfa or forage crops may be grown under irrigation. Fruit production has been developed to only a small extent, but the areas of deeper soils under irrigation are capable of being utilized quite extensively in favorable localities for this purpose.

The soils of this group are usually friable, but sometimes of rather compact character, with a tendency to puddle when wet and to assume unfavorable conditions of structure where improperly handled. Under such conditions they are usually less retentive of moisture than the members of the fine sandy loam or sandy loam groups.

Under favorable conditions they are probably somewhat better adapted to forage crops, grains, olives, pears, and citrus fruits than the residual soils of lighter texture. In the development of intensive agriculture, irrigation will be desirable or necessary in most of the arid and semiarid districts. The installation of irrigation systems would generally be expensive and warranted only in the areas of deeper soil more favorably located for the growing of fruits. The loam soils require a moderately heavy farming equipment.

Altamont loam.—The soil consists of a brown to light-brown loam. The subsoil is similar to the soil in color, texture, and structure. This material rests, at a depth of 2 to 3 feet, on light yellow to yellowish-gray material grading into sandstone and shale. The type is of residual origin and occupies rolling to rough foothills. It is used for grain production and for grazing.

Arnold loam.—The soil is grayish brown, sometimes of a somewhat purplish hue, to dark chocolate brown loam, from 10 to 15 inches deep, in places grading into the red color of adjacent soils of the San Joaquin series and carrying some coarse, sharp sand. The subsoil is a heavy, sticky, light-brown loam or clay loam containing coarse sandy material. The type is generally less retentive of moisture than the Arnold sandy loam. In favorable situations it is adapted to the production of dry-farmed crops.

Auburn loam.—The soil is a red loam of decidedly silty texture and of friable structure, although sticky when wet. The subsoil is a compact clay loam or clay, usually of a deep red. The subsoil rests upon bedrock, which is usually encountered at a depth of less than 6 feet. Rock outcrop and angular rock fragments are of frequent occurrence. The type is of residual origin, derived from amphibolities, diabase, and related rocks. In most cases it is not favorably situated for irrigation, and in many places the natural supply of moisture

is inadequate for agriculture. Where topography and other conditions permit, the type is well adapted to the production of citrus, deciduous, and small fruits. The type is usually timbered, except over the shallow and arid areas.

Daulton loam.—The soil is a reddish-brown sticky loam, usually from 15 to 28 inches deep. It is underlain by a yellowish-brown loam or sandy clay loam grading at various depths into a substratum of yellow sandy loam resting upon bedrock. The topography is rough and irregular, often broken by rock outcrops, ridges, steep slopes, and ravines. Drainage is somewhat excessive. Valley oak, live oak, and buckeye flourish along hill slopes. The more level areas are devoted to hay and grain.

Diablo loam.—The soil is a dark-gray, compact, sticky loam. The subsoil is similar in color, texture, and structure to the soil, and is underlain by a substratum of light-colored, impure, argillaceous sandstone. The type is of residual origin. It occupies the summits and slopes of the lower, treeless foothills, and has good surface drainage. It is rather impervious to moisture, inclined to check, and resembles the adobes in structure. Underdrainage is poor. Irrigation is impracticable, as the soil is often shallow and unproductive. The type is used principally as grazing land and to some extent for dry farming.

Melbourne loam.—The type consists of a brown to dark-brown loam about 30 inches deep with a noticeable content of shale fragments, underlain by a yellow to drab subsoil which becomes siltier in texture with increased depth. Both soil and subsoil incline to an adobe structure, especially during the dry season. The soil is of residual origin and derived predominantly from shales. Where favored by topography and climatic conditions fair crops of finely colored apples and apricots are produced.

Olympic loam.—The soil is a light-brown to brownish loam with an average depth of 12 inches, carrying variable amounts of decomposed fragments of basaltic rock and soft iron pellets. The subsoil is of loam or silty loam texture, similar in color to the soil material. The type is of residual origin and derived from basaltic rock. Rock outcrop is of occasional occurrence along the steeper eroded slopes and ridges. The topography ranges from comparatively level to rough and broken, and is frequently marked by evidences of landslides. Much of the type is best adapted to forestry, but the more level areas are suitable for dairying and for the production of oats, potatoes, clover, timothy, and fruit crops.

Sites loam.—The soil is of rather dark brown color, with a reddish tint, and generally free from gravel or rock fragments. The subsoil is similar in color and texture to the soil and underlain by sandstone at depths ranging from a few inches to 6 feet or more. The type is of residual origin, derived from sandstone. The topography varies from sloping to rolling or sometimes rough and broken. In the areas so far mapped the soil is generally shallow and treeless, and of moderately sloping topography. The deeper areas of smoother surface where favorably located are adapted to peaches, vegetables, and small fruits.

Tolo loam.—The soil is a light-brown to brown loam of rather fine texture. The subsoil is a brown to reddish-brown clay and is underlain by bedrock, which may be encountered at any depth below 6 inches. Rock outcrop is of occasional occurrence. The type is of residual origin and derived from diabase and related rocks. Much of it is of rough, mountainous character and heavily forested. Where of sufficient depth and favored by climatic conditions, the type is adapted to pears, apples, and grapes.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Olympic loam	Washington 5, 7	334,336
Tolo loam	Oregon 4	87,680
Arnold loam	California 13	21,504
Altamont loam	California 9	9,024
Auburn loam	California 12	8,512
Melbourne loam	California 14	5,184
Diablo loam	California 2	3,200
Sites loam	Oregon 4	1,536
Daulton loam	California 8	1,280
Total		472,256

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

This phase of the loam group of soils includes those of loam texture characterized by the presence of stone fragments or bowlders in sufficient quantities to affect materially the agricultural value of the land or its adaptation to crops.

Wide areas of stony loam have, in the Residual province of the Pacific Coast region, been encountered, but recognized only in two soil series. They occur most extensively in the humid, forested districts in western Washington. Owing to their rough topography and stony and rocky character they are best adapted to forestry, only areas of small extent being suitable for agricultural purposes.

Other areas occur along the eastern border of the interior valley in California. These areas are sparsely timbered or barren. The soils are shallow, stony, unretentive of moisture during periods of drought, and generally suitable only for grazing.

The stony loam soils are of but little importance in the province and capable of utilization or development only within relatively narrow limits.

Arnold stony loam.—The soil is a heavy, dark-colored, compact loam of smooth, silty texture, from 6 to 30 inches deep, grading into a light-red loamy subsoil, underlain by volcanic muds and breccias. The surface is generally strewn with rounded andesitic cobbles and bowlders. The type is derived from volcanic andesitic breccias and mud flows. It generally occupies flat-topped ridges or elevated, nearly level table-lands. The type sometimes supports a sparse growth of brush or timber, but is usually treeless. Local depressed areas are poorly drained. The type is usually shallow and unproductive, and used mainly for grazing.

Olympic stony loam.—The soil is a light-brown to medium-brown heavy loam or clay loam, the immediate surface being dark colored, owing to accumulation of organic matter. The subsoil material which occurs at depths ranging from 1 to 6 feet is noticeably lighter in color than the soil, and consists of a compact clay loam or silty clay loam. Angular basaltic rock fragments and iron concretions are found throughout the type and rock outcrop is frequently encountered, particularly along the steeper or eroded slopes and ridges. The type is of residual origin, being derived from basaltic rock. It occupies rough, hilly, or mountainous areas, usually heavily forested, and only limited areas of comparatively level character are suitable for agricultural purposes. Drainage is well established.

Area and distribution of the stony loams.

Soil name.	State or area.[1]	Acres.
Olympic stony loam	Washington 7	663,040
Arnold stony loam	California 18	30,080
Total		693,120

[1] For key to numbers in this column see p. 733.

LOAM ADOBE PHASE.

The loam adobe phase of the loam group is confined to a single series of soils and to the semiarid foothill sections of the Sierra Nevada Mountains adjacent to the interior valley in California.

The soil is characterized by the usual structural features of adobe soils. It is sticky and tenacious, when wet it readily puddles, and bakes hard and checks during hot, dry periods. A large proportion of the loam adobe areas so far mapped is rough and stony and broken by rock outcrop. For this reason, and because of its shallow depth, it is not well suited to agriculture. The deeper areas of favorable topography are usually devoted to the production of grain and grain hay without irrigation. The rougher areas are used for pasture. The soil has a high water-holding capacity, and when in favorable structural condition is retentive of moisture. A well-granulated structure can be maintained by proper methods of cultivation, and under intensive methods suitable areas may be used for the production of table and wine grapes, and possibly for the later tree fruits.

The soil requires heavy farming equipment, and it is difficult to handle except under the most favorable moisture conditions. In physical character and relation to crop adaptation it is more nearly related to the soils of heavier texture than to the members of the sandy-loam group.

Sierra loam adobe.—The soil is a dark-red, heavy loam, of close, compact adobe structure, very sticky when wet, readily puddled, and inclined to check upon exposure. The subsoil is a red to dark-red heavy adobe. The type is derived mainly from the weathering of underlying gabbro-diorite rock, which frequently outcrops in angular, rugged ledges over extensive areas. It usually occupies high, rugged hills and intervening valleys and is frequently covered with a dense growth of brush or small timber. The deeper areas possess well-developed moisture-retaining properties and are adapted to grains, hay, and grapes, with or without irrigation.

Area and distribution of the loam adobe.

Soil name.	State or area.[1]	Acres.
Sierra loam adobe	California 18	10,944

[1] For key to number in this column see p. 733.

Silt Loam Group.

The silt loams occupy a relatively small area in this province, only a single soil—the Olympic silt loam—having been mapped to this time.

This type is found only in the humid, heavily forested sections of western Washington. A large proportion of the area is of rough, hilly, or mountainous topography and best suited to forestry. The type includes, however, some extensive areas capable of being utilized for farming purposes and adapted to the production of oats, hay, and forage, the growth of these crops being favored by a moist, cool climate.

Apples and small fruits and late or heavy vegetables can probably be grown successfully on areas of deeper soil and even surface, permitting intensive cultivation. The soil is at present utilized for agriculture only to a limited extent. In adaptation to crops it does not depart greatly from the loam member of the same series. It is friable under cultivation and is usually well drained and capable of being maintained in a favorable state of cultivation by means of the average farming equipment. Owing to frequent rough topography and to lack of adequate roads and transportation facilities, however, heavy draft stock will be necessary, and the production of intensively cultivated or perishable products is not practicable under present conditions.

Olympic silt loam.—The soil is of light-brown color, usually with a reddish tint, from 15 to 16 inches deep, though the immediate surface is often locally of dark-brown color, owing to large organic matter content. The subsoil is a light-brown to yellowish-brown silty clay loam. The type is of residual origin, derived from basaltic rock, and occupies elevated table-lands or rough, mountainous areas. Favorably located areas are suitable for dairying, general farming and fruit growing.

Area and distribution of the silt loam.

Soil name.	State or area.[1]	Acres.
Olympic silt loam	Washington 7	39,424

[1] For key to number in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loams of the Residual province of the Pacific coast region occur more frequently and are more extensively developed than the soils of the silt loam group. They are, however, confined to the heavily forested humid region in the northwestern part of the province. They are subject to wide

variation in topography, depth of soil, and other factors limiting or modifying their adaptation to crops.

Only a small proportion of the area surveyed has been used for agriculture, as much of the rougher and mountainous regions are topographically unfitted for agriculture and best left in forest. Extensive areas occur, however, which. so far as topography or physical characteristics of the soil are concerned, may be profitable for agriculture. Climatic conditions are generally favorable to the production of native grasses, oats, clover, timothy, and other hay and forage crops, to which the soils are well suited. Thus, dairying may be extended upon these soils. Over many of the areas covered by the silty clay loam the production of less highly concentrated farm products or of perishable fruits or vegetables is impracticable, owing to undeveloped transportation facilities. Apples, small fruits, and late vegetables may be grown. however, under favorable local conditions of topography, location, and climate. The soils are generally friable, retentive of moisture, and well drained. A rather heavy farming equipment will be necessary in their development, owing to their compact structure, prevailing rough topography, and the difficulty of hauling over hilly roads.

Aiken silty clay loam.—The type consists of a reddish-brown to dark-brown silty clay loam underlain at a depth of 10 to 12 inches by a reddish-brown to brown silty clay loam subsoil, which usually becomes heavier in texture and more compact in structure with depth. Fragments of basaltic rock are found throughout the soil section. The topography is comparatively level to rolling. The type is mainly in forest, only a comparatively small proportion being devoted to agriculture. A large part of it can be placed under cultivation, grains, hay, vegetables, and tree fruits being best suited to the soil.

Melbourne silty clay loam.—The soil is a light-brown to dark-brown silty clay loam, usually sticky when wet, but friable under cultivation. It often contains soft rock fragments and iron pellets. The subsoil is a yellowish-brown to brown and sometimes mottled clay loam, which rests upon bedrock. The type is residual in origin, and, where mapped, heavily forested. Where surface configuration and climatic conditions permit, the deeper areas are adapted to grain, hay, and fruit crops.

Olympic silty clay loam.—The soil is a light-brown to medium brown silty clay loam of friable structure, 6 to 24 inches deep. Accumulations of organic matter frequently give the immediate surface a dark-brown color. The subsoil is a compact, yellowish-brown to brown silty loam or silty clay, which rests upon bedrock at depths ranging from 1 to 6 feet or more. Small quantities of angular to subangular rock fragments are found upon the surface and mixed with the soil and subsoil. Rock outcrop occasionally occurs. The type is of residual origin and derived from basaltic rock. The topography ranges from rolling to rough and mountainous. The soil is well drained, but retentive of moisture, and under favorable conditions of topography and climate is adapted to the production of general farm and fruit crops. At present little of it is used for farming.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Melbourne silty clay loam	Washington 5, 7	1,099,456
Olympic silty clay loam	Washington 7	418,048
Aiken silty clay loam	do	12,032
Total		1,529,536

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

Clay loam soils have been encountered in the Residual province under four series. Two of these clay loams have been mapped in the Sierra Nevada foothills and cover extensive areas of rolling to rough and broken lands bordering the great interior valley. Another has been encountered near the interior valleys of southern Oregon. The most widely distributed member of the group belongs to the Altamont series, and is encountered in the coastal districts of

California and southern Oregon. It is subject to a much greater range in climatic conditions than the other members of the group, all of which. however, vary locally in climate, topography, drainage, moisture supply, depth, and other important features.

In the humid districts of Oregon, oats, wheat, and clover and other hay crops are the principal products, although the soil has been used for farming only to a limited extent. Local areas are well adapted to apples, pears, plums, and bramble or bush fruits, while transportation facilities and climatic conditions favor the production of dairy products. In the coastal districts of California, wheat and barley, frequently cured for hay, are the most extensively grown products of the clay loams. The yields are, however, rather low, except in usually favorable seasons, much of the land being steep, broken, or excessively drained, and the soil often shallow and unretentive of moisture. Under favorable local conditions of climate, however, suitable areas produce excellent crops of apples and pears, and where capable of irrigation, of strawberries and bramble fruits.

In the interior districts of southern Oregon and California, extensive areas of the clay loams are of shallow, rocky character, or of rough topography and utilized only for grazing or, where machinery can be used, for the production of shallow-rooted grain and grain hay crops. The deeper and less broken areas have in certain districts, however, been highly developed in the production of grapes, cherries, peaches, pears, and apples, and where favored by local climatic conditions are suitable for citrus fruits. With the practice of more intensive and efficient cultivation and the development of irrigation where possible the production of fruits in suitable areas is capable of much further extension.

The soils of this group are usually sticky when wet and require frequent and thorough cultivation for the maintenance of a favorable condition of tilth. They are retentive of moisture under proper management, usually well drained, and where of suitable depth, topography, and location, are adapted to grains, hay, and forage crops, late table and wine grapes, apples, pears, bramble fruits, and the late stone fruits. While less excessively drained than the soils of lighter texture of this province and of somewhat later character, they are sometimes so situated with regard to good drainage and freedom from frosts as to successfully compete in the production of moderately early fruit products with soils normally better adapted to early fruit production, but occupying lower, less well drained, and more exposed positions.

A rather heavy farming equipment is required for their effective and economical management.

Altamont clay loam.—The soil is a light-brown to dark-brown clay loam from 6 to 30 inches deep, containing in places considerable quantities of angular rock fragments. It is underlain by a yellow clay loam or silty clay loam which rests upon bedrock at varying depths up to 6 feet. When dry the surface soil occasionally shows shades of yellow or reddish yellow and approaches an adobe structure. The type is of residual origin and derived from shale rocks. The surface is sloping to hilly, and dissected by gulches and ravines, often so steep as to preclude cultivation. Drainage is naturally excessive, but the soil is retentive of moisture. It is often covered by a dense growth of live oak, poison oak, and a variety of shrubs and trees, or in humid districts is heavily forested. Areas capable of cultivation are devoted to dry-farmed hay and grain, the remainder being used mainly for pasture. Apples, pears, berries, and bush fruits are grown to a small extent in areas of heavier rainfall.

Auburn clay loam.—The loam is a bright-red to deep-red silty clay loam. It is decidedly sticky when wet and tends to puddle and bake upon exposure, but is friable under cultivation. The subsoil is a somewhat deeper red than the soil and of slightly heavier texture and more compact structure. It is underlain by bedrock, usually at a depth of less than 6 feet. Rock outcrop is of frequent occurrence, and angular rock fragments are found in both soil and subsoil. The type is of residual origin, being derived from diabase, amphibolites, and related rocks. Much of the type is too rough and broken and of too shallow depth to permit of cultivation. The deeper areas of favorable topography and climatic conditions are well adapted to fruits and extensively utilized for the production of olives, grapes, and other fruits. The type constitutes one of the most important deciduous fruit-producing soils of the northern and central foothill region in California.

Daulton clay loam.—The type consists of a light-brown to light reddish brown compact clay loam resting on a subsoil of similar material underlain by disintegrated and partially weathered parent rock consisting mainly of schist with

included quartz. The surface is rolling to hilly with frequent rock outcrops appearing as conspicuous lenses or masses of light-colored quartz occupying the summits of rounded or sloping hills. This type is utilized mainly for grazing, but small areas of level surface are devoted to dry-farmed grains. It is not an important agricultural type, though small, favorably situated areas could, under irrigation, be utilized for the production of fruits.

Olympic clay loam.—The soil is a light-brown to brown clay loam from 12 to 24 inches deep, of compact structure and somewhat sticky when wet. The subsoil is a compact clay or clay loam of the same color as the soil resting upon bedrock at a depth of 1 to 6 or more feet. The type is of residual origin, being derived from basaltic rock, and occupies sloping to hilly and broken areas. It is usually well drained, and where of sufficient depth and capable of cultivation is suitable for the production of general farm crops and fruits.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Altamont clay loam	California 8, 14; Oregon 3	234,496
Auburn clay loam	California 18	128,183
Daulton clay loam	California 11	9,280
Olympic clay loam	Oregon 4	3,264
Total		375,223

[1] For key to numbers in this column see p. 733.

STONY CLAY LOAM PHASE.

This phase includes the clay loam soils of the Residual province marked by the presence of stone fragments or bowlders in such quantities as to render this feature an essential characteristic of the type and to limit or modify the value of the soil for agriculture.

Soils of this character have been recognized by the soil survey in two soil series only. The usual influence of the stone content in the silty clay loams, where not too excessive and where other conditions are favorable, is to render the soil more porous, less retentive of moisture, and better adapted to fruits or other products requiring well-drained, moderately early soils. In this province, however, the soils recognized under the stony clay loams are generally of rough, broken topography. They often occupy elevated, rugged, mountainous districts, are frequently marked by landslides, and are of shallow depth and very stony. Only the deeper soils of less broken contour are suited to agriculture. They are of minor agricultural importance and best adapted to forestry and to grazing.

Daulton stony clay loam.—The type consists of 10 to 24 inches of brown or reddish-brown clay loam, underlain by light-brown clay loam, which persists until the underlying rock is encountered at an average depth of 36 to 48 inches. When dry, the soil is a grayish yellow or light brown. Where the soil covering is shallow, the clay loam subsoil is often wanting, and there is a layer of yellowish sandy loam immediately above the rock. Small angular rock fragments are found in both soil and subsoil in large quantities. Over a large part of the type there is only a shallow covering of soil over the rock, while outcrops are numerous, especially on the steep slopes. The type is of residual origin, derived from schists. It occupies rough and hilly areas with narrow ridges. Drainage is excessive. The native vegetation consists of field and live oak and buckeye. The type is devoted mainly to grazing.

Olympic stony clay loam.—The soil is a light-brown to medium-brown clay loam and usually extends to a depth of 12 to 18 inches. The subsoil is a light-brown to yellowish-brown heavy clay loam. This is underlain by basaltic bedrock at depths ranging from a few inches to several feet. The type is of shallow depth upon the steeper slopes, and outcrops of the underlying rock frequently occur. Both soil and subsoil material usually contain a variable amount of small iron pellets and weathered angular fragments of basalt, some of the latter being from 2 to 4 feet in diameter. The type is of residual origin and derived from basaltic rock. Drainage is well established and sometimes

excessive. The rocky character of the soil, its average shallow depth, and the steep, broken topography render the type of small agricultural value.

Area and distribution of the stony clay loams.

Soil name.	State or area.[1]	Acres.
Olympic stony clay loam	Washington 7	26,368
Daulton stony clay loam	California 8	1,280
Total		27,648

[1] For key to numbers in this column see p. 733.

CLAY LOAM ADOBE PHASE.

In the residual clay loam adobe soils of the Pacific Coast region, the adobe characteristics of structure are highly developed. The soils are exceedingly tenacious when wet, puddle readily, and tend to bake and check extensively upon drying. Cultivation is difficult except under proper moisture conditions. When in a favorable condition of moisture, however, the soils are readily tilled, friable, and frequently acquire during the dry season a granulated surface structure which checks evaporation. This renders them retentive of moisture and well adapted to dry-farmed crops.

Surface drainage is well developed and often excessive, but underdrainage is restricted owing to the heavy, relatively impervious character of the subsoil. This makes the soils cold and late. The topography varies from gently undulating or rolling to hilly and broken. The clay loam adobes have been encountered only in the semiarid foothill districts in the vicinity of the interior and coastal valleys of California. The surface is usually treeless. Lands of this type are utilized almost exclusively for grazing and the production of grain and grain hay. The larger portion of it is not favorably situated for irrigation and hence not adapted to intensively cultivated crops. More favorably situated areas could probably be utilized for the production of pears, and some of the more elevated and rugged areas for the growing of eucalyptus or other forest trees.

The clay loam adobes are best suited to grains and general farm crops where topographic and climatic conditions are favorable. Owing to their heavy structure they are not adapted to general fruit culture, and in use are more closely related to the soils of the clay group, and to the clay adobe phase. They require the heaviest farm equipment, such as is suitable to refractory soils, hilly topography, and an extensive system of farming.

Diablo clay loam adobe.—The soil is a sticky clay loam of dense adobe structure, varying in color from chocolate-brown or dark gray to nearly black. The upper subsoil is of dark-gray or black color and similar to the soil material in texture and structure. It is usually calcareous and often marly. It is underlain at an average depth of about 3 feet by a deeper subsoil, consisting of a compact, red clay, or clay loam adobe, or occasionally by indurated red clay, iron hardpan. Small water-worn pebbles are frequently found in the surface soil. The type is residual in origin, being derived mainly from shale, with some sandstone and conglomerate. It occupies undulating to rough foothills and has good surface drainage. On account of its rough surface it is unsuited to irrigation, and is devoted to grazing and the production of dry-farmed grain.

Melbourne clay loam adobe.—The type consists of 20 to 30 inches of black or very dark-brown clay loam adobe or sandy clay adobe, underlain by a yellow clay loam to a depth of 4 feet which grades into a mass of partly decomposed shale fragments and gravel extending to a depth of 6 feet or more. The type is a residual soil derived from decomposing shales. Where mapped it occupies lower foothill slopes and valley plains, is treeless, and devoted to grain crops and pasturage.

Area and distribution of the clay loam adobes.

Soil name.	State or area.[1]	Acres.
Diablo clay loam adobe	California 2, 25	44,160
Melbourne clay loam adobe	California 14	1,600
Total		45,760

[1] For key to numbers in this column see p. 733.

Clay Group.

The soils of the clay group are less extensively developed than are many of the previously described residual soils of the province. Three types have been mapped, and these are confined to the subhumid and humid districts in Oregon and Washington. They are derived predominantly from basic rocks.

The larger proportion of the area included is of hilly or mountainous topography. The soil mantle is shallow and landslides frequent. For these reasons the development of agriculture has been slow, and the greater part of the soils are still in forest. The group requires heavy farming equipment. Where capable of cultivation the soils are adapted to grains, including wheat, oats, and barley, and to clover, vetch, and timothy. Areas subject to erosion are best used for forestry or for permanent cover crops.

Aiken clay.—The soil consists of a dark reddish brown to dark brick red sticky and tenacious clay, from 6 to 15 inches deep. The subsoil is a heavy clay loam or clay of bright Indian-red to dark-red color, extending to the depth of 3 feet or more and underlain by parent rock. The surface 2 or 3 inches of the type often carries an appreciable amount of fine sand, representing waste from the finer material, and accumulations of organic matter impart a dark color to the soil. Rounded or subangular fragments of igneous rocks, from 6 to 12 inches in diameter, are found in the surface, but not in sufficient amounts to interfere with cultivation. The soil, which is of residual origin, is derived from basaltic rocks. The type occupies steep, rocky hill or mountain slopes to undulating or moderately sloping areas near the base of hills and ridges and in the humid areas is covered with forest. Little of it is at present cleared or farmed, and the rougher areas are adapted only to forestry or grazing. The more moderate slopes when cleared are suitable to the production of grain and hay crops.

Melbourne clay.—The soil is a reddish-brown to dark-gray clay from 10 to 18 inches deep carrying in places quantities of gravel and angular rock fragments. The subsoil is a compact, yellow to light-brown clay or clay loam, resting upon bedrock at from 3 to 6 feet or more. The type is of residual origin and derived from sandstone and interbedded shale and conglomerate. Rock outcrop is of occasional occurrence. Drainage is well established. The topography varies from rolling or undulating to steep, rocky, and dissected. Where well supplied with moisture and of sufficient depth the type is forested. It is not extensively devoted to agriculture, although utilized to some extent for grazing or for hay crops.

Olympic clay.—The soil is a light-brown to brown clay, sticky and waxy when wet, and from 12 to 15 inches deep. Locally the immediate surface is quite dark owing to the presence of much organic matter. The subsoil is a loam or slightly mottled, heavy, plastic clay. Rock fragments and iron pellets are a common constituent. The type is of residual origin and derived from basaltic rock. It frequently includes a large amount of landslide material. The topography varies from comparatively level to steep and broken. The type is well drained. It has been developed to agriculture to but a limited extent. Where capable of cultivation it is adapted to the general farm crops.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Aiken clay	Oregon 3, 4, 5	97,408
Melbourne clay	Oregon 3	44,608
Olympic clay	Washington 7	4,352
Total		146,368

[1] For key to numbers in this column see p. 733.

STONY CLAY PHASE.

Stony clay soils have been recognized in this province only in one series, which is confined to the humid, forested districts of western Washington.

The type here found is of rough, broken topography, and much of the areas covered are best adapted to forestry, owing to their inaccessibility and lack of transportation facilities, to the frequently excessive amounts of stone, and the shallowness of the soil material. The soil is excessively drained and somewhat subject to erosion if cleared and devoted to cultivated crops. It is not at present used for agriculture. Local areas are suitable for dairying and for the production of oats, hay, and forage crops, and occasionally of tree or small fruits. The type does not depart greatly in crop adaptation from the members of the clay group of the same series although somewhat more promising for the culture of fruits and vegetables.

Aiken stony clay.—The soil is a clay of dark reddish-brown color and compact structure. It usually contains a large amount of basaltic rock fragments. The subsoil is a red to reddish-brown heavy clay. Along the steeper slopes the soil material is shallow and underlain by bedrock near the surface or frequently marked by rock outcrop. The type is of residual origin and derived from basaltic rock. The topography is usually steep and broken and much of the type is of little agricultural importance and best adapted to forestry. Drainage is well established and frequently excessive over the steeper areas. Where capable of cultivation the type is adapted to dairying, hay and forage crops, and sometimes to fruit.

Area and distribution of the stony clay.

Soil name.	State or area.[1]	Acres.
Aiken stony clay	Washington 7	26,624

[1] For key to number in this column see p. 733.

CLAY ADOBE PHASE.

The clay adobe soils of the Residual province are of much more widespread and frequent occurrence than those of the clay group. They are confined to the subhumid and semiarid foothill districts surrounding the interior valleys in Oregon and California and adjacent to the coastal valleys in the latter State.

In structure, drainage and tillage conditions, power to retain moisture, and in crop adaptation the clay adobe soils are similar to the clay loam adobes.

The former are subject to much variation in depth and character of topography, but in many places they are shallow and of steeply rolling to rough broken character and best adapted to grazing or to forestry. Where utilized they are generally devoted to pasturage or the production of dry-farmed wheat, barley, and grain hay. While retentive of moisture under favorable conditions, the soils are cold, wet, and late, and often deficient in moisture, owing to excessive surface drainage, shallow character, and to unfavorable structure. They require heavy farming equipment.

Aiken clay adobe.—The soil consists of a dark-red to reddish-brown heavy, tenacious clay of adobe structure, the surface few inches often being dark brown in color, owing to accumulations of organic matter. The subsoil is of bright-red to brick-red color and of heavy compact character, and underlain at

shallow depths by basaltic bedrock. Rock outcrop and basaltic rock fragments varying in size from small gravel to bowlders frequently occur. The type is residual from basaltic rock. Drainage is well established and frequently excessive, but the soil is retentive of moisture. Owing to its shallow character and the predominant rough topography the type is of minor agricultural importance, but where of sufficient depth and capable of cultivation it is adapted to the production of general farm or fruit crops suited to the locality and to soils of heavy texture.

Altamont clay adobe.—The soil is a brown to dark-brown clay or silty clay of adobe structure, sticky and tenacious when wet and tending to crack when dry. A few cobbles and shale fragments occur on some of the higher peaks and ridges, with outcrops of sandstone on steep slopes. The subsoil consists of a yellowish-brown clay loam of silty character grading into a sandy loam, resting upon a bedrock substratum. The type is derived through weathering from sandstones and shales with a small amount of limestone and conglomerate material. The topography is hilly, with steep slopes to the streams. The soil is used for dry-farmed grain and grain hay.

Arnold clay adobe.—The soil is a dark-gray or purplish-brown to black clay adobe, carrying in places a noticeable content of angular sand. The subsoil is similar in color, texture, and structure to the soil material and underlain at a depth of a few inches to 3 feet or more by a light-colored stratified substratum of volcanic ash, volcanic breccias, or andesitic tufts. The soil bakes and cracks upon exposure during the dry season, is very sticky when wet, and frequently carries rounded gravels or cobbles and sometimes angular andesitic fragments.

Climax clay adobe.—The soil is a black or dark chocolate brown clay of adobe structure. The subsoil varies from brown to black in color, is heavy and compact, and rests upon a bedrock substratum encountered at depths usually below 6 feet. Small, angular rock fragments frequently occur in the soil and subsoil material. The type is of residual origin and derived from basaltic rock, outcrops of which occur throughout the type. Considerable colluvial material is found in areas occurring along low slopes. Where mapped the type is utilized mainly for grazing. It is rather deficient in moisture-retaining capacity, but under favorable conditions of climate moisture supply and depth can be used for the production of pears.

Daulton clay adobe.—The soil is a deep-red to brownish-red clay of adobe structure, carrying considerable quantities of angular and subangular rock fragments, largely siliceous. The subsoil is similar in color, texture, and structure to the soil. The type usually occurs as irregular bodies, of small extent, occupying elevated rolling foothills. It is devoted to dry farming to grains, with fair results in favorable seasons. The soil is not particularly retentive of moisture, but where irrigation is possible favorably situated areas could probably be used for the production of grapes and other fruits adapted to heavy soils, including, possibly, citrus fruits.

Diablo clay adobe.—The soil consists of a dark grayish brown to dark gray clay of refractory, adobe structure. The upper subsoil is similar to the surface material in color, texture, and structure. It is usually calcareous, and extends to a depth of 18 to 36 inches. The deeper subsoil consists of a compact red clay, containing considerable rounded gravel, which is sometimes displaced by light-gray or white, calcareous, marly material resting upon calcareous shales. The type is of residual origin and derived from shales, usually of calcareous character, with some conglomerates. Drainage is well established. The topography is rolling to hilly, the soil areas being dissected by numerous narrow valleys. The native vegetation consists of scrub oak, manzanita, chaparral, and oak. The lower lying bodies are usually treeless. The principal crops grown are wheat, barley, and hay. The type is also utilized for grazing.

Olympic clay adobe.—The soil is a light-brown to rather dark brown, heavy, compact clay adobe. The subsoil is heavy and compact, slightly lighter in color, and rests upon bedrock at a depth of 1 to 6 feet or more. Rock fragments and rock outcrop are of frequent occurrence. The type is of residual origin and derived from basaltic rock. It occupies sloping to rolling or rough foothill and mountain areas. Much of it is too shallow to be of great agricultural importance, and is best adapted to grazing. Cleared areas, where of sufficient depth and favored by climatic and topographic conditions, are adapted to hay or other general farm crops and fruits.

Sierra clay adobe.—The soil consists of 36 inches to 6 feet or more of a heavy clay adobe, carrying in some places fine, water-worn gravel. It is of deep red to reddish-brown color, very sticky when wet, and cracks badly upon exposure

to dry weather, forming large, hard clods. Unaltered or partially weathered granitic rocks, from which the type is derived, may be found at any depth below 36 inches. It occupies rolling areas, generally lying below more elevated bodies of Rough stony land, the surface being relatively uniform in character, but of considerable slope.

The type is devoted largely to grazing and is of inferior value for the production of dry-farmed grains. Where irrigated it may be used for other crops, but lack of water supply or cost of distribution generally preclude this practice.

Area and distribution of the clay adobes.

Soil name.	State or area.[1]	Acres.
Diablo clay adobe	California 8, 25	125,248
Arnold clay adobe	California 13	23,296
Olympic clay adobe	Oregon 4	23,040
Climax clay adobe	......do	17,216
Altamont clay adobe	California 8	11,136
Daulton clay adobe	California 8, 11	2,176
Aiken clay adobe	Oregon 4	768
Sierra clay adobe	California 11	448
Total		203,328

[1] For key to numbers in this column see p. 733.

GLACIAL MATERIAL.

The soils of this group are derived from intermixed eroded material deposited by glacial agencies, embracing the deposition of the unassorted glacial material, or till, directly by the ice and of the outwash material in an assorted and stratified state by rushing water of glacial streams.

The glacial deposits vary in depth and the extent of their modification by underlying material. Likewise the drainage, moisture-retaining capacity, and adaptability to crops may be influenced by the extent to which assorting of the material by outwash waters may have taken place and the depth at which the coarser deposits may occur.

The arable soils derived from glacial material are confined to the extreme northern part of the region. Glaciated areas occur southward along the higher peaks and crests of the Cascade and Sierra Nevada Mountains, but because of their altitude and topography, such areas are usually unsuited for agriculture.

Lying within a humid region, the soils of this group are heavily forested and only a comparatively small proportion of their total area has been cultivated. Where the topography is favorable and the conditions of climate, drainage, and moisture supply satisfactory, they are adapted to the small grains, hay crops, dairying, stock raising, and possibly to trucking and fruit growing through intensive methods of cultivation.

DESCRIPTION OF THE SOIL SERIES.

Buckley series.—The soils are dark brown to black, varying from 8 to 12 inches in depth, and contain an abundance of decomposed organic matter and some fine gravel and particles of coarse, sharp sand. The subsoil is compact, fairly impervious, and of dark-gray or bluish-gray color mottled with yellow or brown iron stains. Coarse, sharp sand, fine gravel, and angular to subangular rock fragments with small glacial bowlders are usually encountered within the soil section. The soils are of glacial origin and consist of Osceola till of the humid Puget Sound region in Washington. They occupy extensive flat to gently undulating upland bench or plateaulike areas frequently bordered by steep slopes and bluffs. The types are heavily forested with fir, cedar, spruce, and alder, and when drained are friable and well adapted to oats, potatoes, hops, hay, and fruits.

Area and distribution of the soil of the Buckley series.

Soil name.	State or area.[1]	Acres.
Buckley loam	Washington 4	27,904

[1] For key to number in this column see p. 733.

Clallam series.—The soils of this series are uniformly light grayish brown to gray, resting upon subsoils of compact, silty loam or silty clay loam slightly lighter in color than the surface soils. Fine glacial gravel and iron pellets occur in all the soil types. The subsoils are of finer texture and more compact structure than the subsoils of the Everett series, and the surface soils are generally lighter in color. They are derived from glacial till and occupy gently rolling upland plateaus. The topography is level to rolling and drainage ordinarily well established. Under favorable moisture conditions the soils are adapted to the production of small fruits, hay, and grain. The native vegetation consists of a heavy stand of fir with small amounts of spruce, cedar, hemlock, and pine.

Area and distribution of the soils of the Clallam series.

Soil name.	State or area.[1]	Acres.
Clallam fine sandy loam	Washington 5	4,096
gravelly fine sandy loam	do	96,256
very fine sandy loam	do	11,520
silt loam	do	512
Total		112,384

[1] For key to number in this column see p. 733.

Dallas series.—The soils consist of dark brown to black glacial and residual material mixed with glacial gravel or bowlders, underlain by compact loamy sand and gravel. Rock outcrop is of frequent occurrence. The soils of this series are derived in part from the disintegration of hard. metamorphosed sandstones, which outcrop along the steeper hillsides, but the presence of glacial gravel and bowlders in the soil shows that the material is partially of glacial origin. The soils occupy benches and plateaus in humid regions near the Pacific coast. The topography is level to sloping and drainage well established. Small fruits, potatoes, and vegetables are the principal crops.

Area and distribution of the soil of the Dallas series.

Soil name.	State or area.[1]	Acres.
Dallas coarse sandy loam	Washington 5	1,280

[1] For key to number in this column see p. 733.

Everett series.—The soils range from light brown to light reddish brown in color and are of silty texture and porous structure. Large amounts of organic matter often occur in the immediate surface, giving it a dark color and loamy texture. In some members of the series small, spherical, iron-cemented pellets are conspicuous. The subsoils are light brown to gray and usually gravelly and porous, the parent material consisting mainly of sands and gravel, with compact silts and clays sometimes occurring in the deeper portions of the deposits. The materials are derived both from basaltic and crystalline rocks. The series supports a heavy growth of fir, cedar, spruce, and hemlock, and occupies humid to subhumid areas of sloping to undulating, plateaulike surface and hilly to mountainous areas. Morainic ridges, kames, and kettle holes are of frequent occurrence. Erosion is more or less active, and

some of the areas are marked by surface or embedded bowlders and occasional gravel outcrops. Drainage is usually excessive, and the soils are subject to drought. Some of the more porous members are adapted only to forestry, while others are adapted to dairying, orchard and small fruits, and general farm crops.

Area and distribution of the soils of the Everett series.

Soil name.	State or area.[1]	Acres.
Everett gravelly loamy sand	Washington 4, 5, 7	421,696
coarse sand	Washington 5	1,536
loamy sand	Washington 4, 5, 7	155,456
sandy loam	Washington 5	18,432
stony sandy loam	Washington 4, 5, 7	71,872
gravelly sandy loam	Washington 4, 5	1,351,296
fine sandy loam	Washington 5	72,960
loam	Washington 4	21,632
stony loam	Washington 4, 5	622,208
silt loam	Washington 5	36,864
Total		2,773,952

[1] For key to numbers in this column see p. 733.

Lynden series.—The soils are light brown to reddish brown, and in the lighter-textured sandy types often light gray on the surface. The subsoil is sandy or gravelly. Drainage is usually excessive. The soils are derived principally from stratified deposits of sand and gravel laid down as outwash by glacial flood waters and in places covered by a thin mantle of unmodified glacial drift. They occupy gently rolling upland terraces and plains or broad, level areas, formerly glacial flood plains and now dissected and eroded. The prevailing timber growth consists of a heavy stand of fir. All of the members of this series are suited to agriculture, the crop adaptation depending upon the characteristics of the individual types.

Area and distribution of the soils of the Lynden series.

Soil name.	State or area.[1]	Acres.
Lynden sandy loam	Washington 4	51,776
fine sandy loam	do	19,904
gravelly loam	do	20,928
silt loam	do	22,144
Total		114,752

[1] For key to number in this column see p. 733.

Orting series.—The soils are dark drab to dark brown, plastic and silty in character, and high in organic matter. The subsoils consist of unstratified sandy loam or loam, sticky and plastic, and usually carrying considerable coarse to medium sand and variable quantities of gravel and glacial bowlders. They range in color from gray to grayish brown, mottled with yellow iron stains. Small waterworn gravel and occasional small glacial bowlders occur in the soil or upon the surface. In position the soils simulate alluvial deposits, but the unstratified nature of the material indicates its glacial origin, though it has not been greatly modified by the assorting action of streams. The series occupies nearly level valleys inclosed by rolling glaciated uplands. The topography varies from level to gently undulating. Drainage is fairly well established, although the series includes many poorly drained, shallow depressions. The timber growth consists of fir, spruce, cedar, and alder. When cleared the soils are adapted to hops, oats, potatoes, hay crops, fruits, and vegetables.

Area and distribution of the soil of the Orting series.

Soil name.	State or area.[1]	Acres.
Orting loam	Washington 4	4,480

[1] For key to number in this column see p. 733.

Salkum series.—The soils are brown to reddish brown in color, and the subsoils range from reddish brown to light brown. The subsoils are underlain at a depth of 3 to 6 feet by beds of soft, stratified glacial outwash gravel which occupy old valley terraces. The topography varies from flat to undulating or gently rolling, the original terraces having been eroded to a considerable extent. The gravels are mainly basaltic in character, but include some andesitic material. The underlying gravels have usually undergone advanced weathering in places having been reduced to a mass of clay or rendered sufficiently soft even at a depth of 10 or more feet to be easily cut by the spade in excavations. The soils are well drained. They are forested, the growth consisting principally of fir and hemlock with some cedar.

Area and distribution of the soil of the Salkum series.

Soil name.	State or area.[1]	Acres.
Salkum silty clay	Washington 7	141,568

[1] For key to number in this column see p. 733.

San Juan series.—The soil varies from dark brown to black when moist and light brown to dark gray when dry. It carries a large amount of organic matter and frequently considerable well-rounded gravel. The subsoil is coarse textured and of loose, porous structure, carrying gravel, glacial cobbles, and bowlders. The soils are derived from deposits of sand and gravel of glacial origin and represent drift or modified drift material. The rolling topography and porous structure of the soil and subsoil make for excessive drainage. The series occupies treeless prairie. So far as mapped it is of little agricultural importance.

Area and distribution of the soil of the San Juan series.

Soil name.	State or area.[1]	Acres.
San Juan coarse sandy loam	Washington 5	768

[1] For key to number in this column see p. 733.

Spanaway series.—The soils are dark brown to black, gravelly, and high in organic matter. The subsoils are gray to brown, of porous, leachy structure, and consist mainly of rounded gravels and cobbles united with sand and extending to an indeterminate depth. They are derived from glacial outwash material.

The series occupies treeless to sparsely timbered, level to undulating plains. The surface is usually hummocky, strewn with cobbles, and broken by narrow ridges, shallow basins, and low, flat-topped terraces. Drainage is excessive and although the soils are often found in regions of moderately heavy rainfall they are subject to drought. The lighter textured and shallower soils are not well adapted to agriculture without irrigation. In favorable seasons and under intensive cultivation the heavier and deeper soils of the series yield fair crops of small fruits, vegetables, oats, barley, and hay. Under irrigation they are adapted to a wide range of crops, including truck crops and fruits.

Area and distribution of the soils of the Spanaway series.

Soil name.	State or area.[1]	Acres.
Spanaway loamy sand	Washington 5	4,864
loamy fine sand	do	9,984
gravelly sandy loam	Washington 4, 5, 7	189,440
fine sandy loam	Washington 4	3,712
Total		208,000

[1] For key to numbers in this column see p. 733.

Townsend series.—The soils are dark brown to black and carry a large amount of organic matter. The subsoils are light colored, contain considerable gravel, and are compact and often relatively impervious when wet. The soil material is derived from glacial till, including pockets of stratified outwash material, apparently modified by conditions of restricted drainage, as indicated by the high content of organic matter. Drainage conditions were subsequently very much modified by the elevation of the material. The series is now well elevated above the waters of Puget Sound, in the vicinity of which the soils occur. The surface is sloping to undulating, and the soils are well drained. In their original condition they supported only a meager growth of fir, pine, and oaks, or were treeless, and in part covered only by a growth of native grasses.

Area and distribution of the soil of the Townsend series.

Soil name.	State or area.[1]	Acres.
Townsend gravelly sandy loam	Washington 5	2,560

[1] For key to number in this column see p. 733.

Whatcom series.—The soils of the Whatcom series are of deep reddish-brown color and prevailingly of fine texture and rather compact structure. Accumulations of organic matter often impart a dark-brown or nearly black color to the surface soil. The subsoils consist of drab to gray, plastic and compact, heavy silts, the upper portions sometimes carrying small amounts of gravel and glacial bowlders. Some of this coarser material also occurs in the soil. Iron pellets are a characteristic feature. The soils are derived from compact ice-laid material of the glacial drift and occupy areas of undulating to rolling upland. The hills are rounded and the slopes never steep or eroded, the areas being often characterized by kame and kettle topography. Drainage is well established. Uncleared areas support a heavy stand of fir, with a small admixture of spruce, cedar, and hemlock. The soils are retentive of moisture and adapted to orchard fruits and small fruits, potatoes, vegetables, and hay crops.

Area and distribution of the soil of the Whatcom series.

Soil name.	State or area.[1]	Acres.
Whatcom silt loam	Washington 4, 5	142,016

[1] For key to number in this column see p. 733.

Winlock series.—The soils of the Winlock series are dark brown to dark gray or black and underlain by brown to dark-brown, compact subsoils. They occupy flat upland terraces where the natural drainage is not completely developed, resulting in accumulations of organic matter and giving rise to dark-colored soils. The soil material is derived from glacial outwash. The native forest growth consists principally of fir, cedar, and spruce. The soils are generally well adapted to general farming crops and to fruit and vegetables.

Area and distribution of the soil of the Winlock series.

Soil name.	State or area.[1]	Acres.
Winlock silty clay	Washington 7	25,088

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

GRAVELLY LOAMY SAND PHASE.

This phase includes sandy soils containing sufficient silt and clay to render them of somewhat adhesive and loamy character and a conspicuous proportion of gravelly material. In physical properties they occupy a position intermediate between the gravelly sands and the gravelly sandy loams, being somewhat more porous and lighter textured than the latter, but more coherent and retentive of moisture than the gravelly sands.

In the Glacial province of the Pacific Coast region the gravelly loamy sands have been encountered under a single soil series. The soil is of loose, porous character, excessively drained, and of low moisture-retaining capacity. The soils are heavily forested, and only small areas are farmed. They are not adapted to the general farm crops and are inferior to the soils of heavier texture of the same series for other purposes. Under intensive cultivation potatoes and early truck crops might be grown to some extent. The initial expense in clearing is heavy, but only a light farming equipment is required to work the soil. It is not of great agricultural importance, and portions of it are best left in forest.

Everett gravelly loamy sand.—The soil consists of a light-brown loamy sand about 10 inches deep, containing from 40 to 60 per cent of medium to coarse gravel. This is underlain by a gray, medium to coarse loamy sand also high in gravel and small cobbles or bowlders. The gravel in the subsoil often occurs in compact beds or pockets many feet in thickness. The soil is derived largely from coarse glacial deposits of sand and gravel, laid down by the floods from the melting ice. The topography varies from nearly level in areas bordering some of the small stream courses, along the margins of small lakes, or on small upland plateaus, to rough and hilly along the steeper slopes of the upland hills and ridges. The coarse gravelly soil permits rapid percolation of water, making the natural drainage so excessive that the soil remains in a dry condition during the summer when the rainfall is light. The soil supports a heavy growth of timber. Very little of this type is under cultivation, although small tracts have been cleared and used for fruit growing and pasture. During favorable seasons fair yields of potatoes and early truck crops have been secured.

Area and distribution of the gravelly loamy sand.

Soil name.	State or area.[1]	Acres.
Everett gravelly loamy sand	Washington 4, 5, 7	421,696

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

The coarse sand phase of the Glacial province of the Pacific coast is represented by a single soil. The material of both the soil and subsoil is of loose, porous character, excessively drained and of low moisture-retaining capacity. Like the gravelly loamy sand of the same series, the surface soil contains accumulations of organic matter. Much of the native timber growth has been removed, and the greater part of the forest humus destroyed by fires. The

expense of clearing is high and crops succumb quickly to drought. Only a light farming equipment is required for working these soils. Farming has not been developed to any extent. Intensively cultivated early tree fruits, small fruits, and truck crops may be grown or the land used for pasture. It ranks somewhat below the members of the same series of slightly heavier texture, and in agricultural importance and crop adaptation closely resembles the gravelly loamy sand of the series.

Everett coarse sand.—The soil consists of a grayish-brown to yellowish-brown coarse loamy sand about 12 inches deep, resting on a coarse loamy sand subsoil of somewhat lighter color. The surface 2 or 3 inches are usually darkened by slight accumulations of organic matter. The structure of both soil and subsoil is very loose and porous. The presence of coarse, clean quartz material in places imparts to the type a lighter color. The type is of glacial origin. The topography varies from nearly level to quite hilly, and drainage is excessive. As a whole the type is of low agricultural value, and very few attempts have been made to cultivate it.

Area and distribution of the coarse sand.

Soil name.	State or area.[1]	Acres.
Everett coarse sand	Washington 5	1,536

[1] For key to number in this column see p. 733.

LOAMY SAND PHASE.

The loamy sands of this province occur in two of the more important soil series. They are found in regions differing somewhat in rainfall and are affected by wide variations in character of the substratum. The forest cover reflects these different conditions. The soils are loose, porous, and leachy, excessively drained, and deficient in power to retain moisture. The topography usually favors agriculture, and one of the types is so sparsely timbered that it can be prepared for cultivation without great expense. It is, however, underlain by a coarse, porous substratum, consisting mainly of gravel and bowlders. The immediate surface contains a large amount of organic matter and is retentive of moisture, and in favorable seasons fair crops of small grains are obtained. The clearing of forested areas is much more expensive, but drainage is not usually excessive, and the soils are fairly well adapted, under intensive cultivation, to early tree fruits, small fruits, and vegetables. The prairie soils of more porous character are adapted to the same crops where capable of irrigation.

The loamy sands require only a light farming equipment when placed under cultivation. They are not adapted to the general farm crops and are most effectively and economically utilized in small, intensively cultivated tracts. In agricultural value they are slightly superior to the gravelly loamy sand and the coarse sand of the province. They may be used for pasture where not devoted to cultivation.

Everett loamy sand.—The soil consists of a brown light sandy loam or loamy sand from 10 to 15 inches deep. The sand varies from medium to fine with a few rounded gravel on the surface and mixed with the soil. The subsoil consists of a gray light sandy loam or loamy sand, also carrying small amounts of rounded gravel. Pockets or thin strata of fine sand, coarse sand, or gravel often occur in the deeper subsoil. The soil material is derived from glacial drift or drift that has been reworked to some extent. The type occupies gently rolling uplands and occurs as a narrow strip along the hillsides bordering the larger stream valleys. The natural drainage is excessive and very intensive methods of cultivation are necessary to conserve enough moisture for the growing crops. When the more level areas are cultivated intensively fair yields of fruits, potatoes, and vegetables are obtained.

Spanaway loamy sand.—The type consists of a loose and incoherent black loamy sand, from 24 to 36 inches deep, underlain to a depth of several feet by a light-brown to gray medium-textured sand. The dark color and loamy appearance of the soil are due to the presence of a large amount of humus. Gravel in small amounts is found in both soil and subsoil, while small areas of a rather

coarse sandy loam are not uncommon. This soil material is derived from extensive deposits of sand laid down by glacial waters. The topography is generally level and drainage well established. The type is easily cultivated under a wide range of moisture conditions, but, owing to the porous structure of both soil and subsoil, crops are likely to suffer from drought. However, in favorable seasons and with intensive methods of cultivation fair yields of oats, hay, rye, barley, and wheat are secured. Under irrigation the soil should be well adapted to a wide range of small fruits, orchard fruits, and vegetables. The type is practically treeless.

Area and distribution of the loamy sands.

Soil name.	State or area.[1]	Acres.
Everett loamy sand	Washington 4, 5 7	155,456
Spanaway loamy sand	Washington 5	4,864
Total		160,320

[1] For key to numbers in this column see p. 733.

Fine Sand Group.

LOAMY FINE SAND PHASE.

But one loamy fine sand has so far been encountered in the Glacial province of the Pacific Coast region. This soil is porous and leachy, with a gravelly subsoil, and is unable to conserve moisture during periods of drought, though this condition is somewhat alleviated by a high organic-matter content in the immediate surface. The forest growth is sparse or entirely lacking, and the type is utilized mainly for the production of grain and hay crops. The general farm crops do not thrive except in favorable seasons and under careful methods of management. Where capable of irrigation, the soil is well adapted to early tree fruits, small fruits, and vegetables, though cultivation along this line has not yet developed to any extent. In crop adaptation the type approaches the loamy sand of the same series, to which it is slightly superior in moisture-retaining properties under intensive cultivation.

Spanaway loamy fine sand.—The soil consists of 3 to 5 feet or more of black, loamy fine sand, resting upon a light-brown to gray fine sand which extends to a depth of many feet. Silt and clay are present in small quantities, the loamy appearance and dark color being largely due to the presence of organic matter. The type is derived from glacial outwash. The topography is comparatively level and broken by low ridges, gentle swells, and shallow depressions. As both soil and subsoil are quite porous, the drainage is inclined to be excessive. Under intensive methods of cultivation small grains and vegetables are grown with good results. Under irrigation this would be an excellent soil for fruit, truck, and general farm crops.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Spanaway loamy fine sand	Washington 5	9,984

[1] For key to number in this column see p. 733.

SANDY LOAM GROUP.

The sandy loams of the Glacial province have been recognized in two soil series. Surface drainage is well established and the topography is usually favorable to agriculture. The underlying material is of porous, open structure, and underdrainage is generally excessive. The soil is not retentive of moisture, except under thorough and effective cultivation.

Field peas, clover, and timothy are grown to a limited extent upon these soils. The general farm crops do not as a rule do well. The types are heavily

forested, and the cost of clearing the land of stumps and undergrowth is often excessive. The cultivated areas are of relatively small extent.

Under intensive methods of cultivation designed to conserve moisture and the intelligent use of green manures the sandy loams of the province are well adapted to the production of potatoes and of bramble fruits, tree fruits, and early truck crops, and will be most economically utilized for such purposes in small tracts. When once cleared and placed under cultivation only a light farming equipment is required.

They are adapted to the same general type of farming as the soils of the loamy sand and loamy fine sand phases of the sand and fine sand groups, but are somewhat more retentive of moisture and of slightly superior agricultural possibilities.

Everett sandy loam.—The soil consists of a light-brown sandy loam about 15 inches deep, containing considerable fine gravel. The subsoil, to a depth of 36 inches, varies from a light sandy loam to loose gray sand of varying grades and containing a considerable proportion of fine and coarse gravel. The type is derived from glacial drift or the same material modified by water action. The topography is rolling, forming more or less extensive upland plateaus. Owing to the porous character of soil and subsoil, the natural drainage is excessive. Only a limited acreage is under cultivation, though the greater part has been logged. Small areas are intensively cultivated to potatoes, tree fruits, and small fruits, which do fairly well. The type is not well adapted to general farming.

Lynden sandy loam.—The soil to an average depth of 12 to 15 inches consists of a gray to light-brown sandy loam or loamy sand, which is underlain by a gray loamy sand, more or less distinctly stratified and often containing an appreciable amount of coarse sand and fine gravel. The sandy deposit which forms the subsoil usually becomes coarser in texture with depth, although small pockets of finer-textured sand or fine gravel are often encountered. The sandy deposits from which this soil is derived were laid down by glacial floods during the period when the broad valleys usually occupied by the type served as an outlet for the waters of the melting ice. The topography varies from nearly level to gently rolling, with low, rounded ridges and knolls which slope gently toward the intervening level areas. Drainage is well established, and unless carefully cultivated crops are apt to suffer from lack of sufficient moisture. The soil supports a heavy growth of timber. Under proper methods for conserving the soil moisture crops do fairly well, but yields are not so large as those obtained on the heavier silty soils. Early vegetables, field and garden peas, clover, timothy, and Irish potatoes are grown to a limited extent, and when properly cultivated give fair yields.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Lynden sandy loam	Washington 4	51,776
Everett sandy loam	Washington 5	18,432
Total		70,208

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

But one type has been mapped so far in this phase group in this province of the Pacific Coast region. The stone consists of glacial cobbles and bowlders. The topography is steep and broken and unfavorable to agriculture. A heavy forest usually covers the areas, except where the land has been logged off or burned over. The stone content is usually sufficient to impede tillage and to increase the cost of clearing and preparing the land for cultivation. The soil type is excessively drained, droughty, and is not adapted to general farming. Only sporadic attempts have been made at cultivation.

In agricultural value and utilization the type is inferior to the normal members of the sandy loam group and more like the lighter phases of soils of the sand group. Under intensive cultivation small areas may be used for fruits and early vegetables and other tracts for pasture.

Everett stony sandy loam.—This soil consists of a brown gravelly sandy loam 12 inches deep, containing glacial bowlders ranging in size from 2 to 3 feet in diameter. These are strewn over the surface and distributed throughout the soil section. The subsoil is composed of 40 to 80 per cent of rounded glacial rocks, the interstitial material consisting of a gray gravelly sand or gravelly sandy loam. The topography varies from nearly level or gently rolling on the bench lands or plateaus to steep and precipitous on the slopes bordering the larger stream valleys. The rolling topography and porous character of the subsoil make drainage excessive. The soil is derived from glacial drift or modified drift, from which the waters of the melting ice have washed a large proportion of the finer material. The greater part of the type is covered with a dense growth of fir and underbrush. Very few attempts have been made at cultivation, although some of the less stony and more level areas might be used for pasture and fruit growing.

Area and distribution of the stony sandy loam.

Soil name.	State or area.[1]	Acres.
Everett stony sandy loam	Washington 4, 5, 7	71,872

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loams vary widely in topography, gravel content, and character of underlying material.

One of the members is characterized by a coarse, porous substratum of gravels and bowlders and occupies gently undulating or level, sparsely timbered or treeless prairies. It is droughty and not adapted to farming, except with frequent and copious irrigation. It can be utilized in its natural condition for pasture only during the winter months.

The other members are underlain by a less porous substratum, but are of loose structure, contain a large amount of gravel, are deficient in power to retain moisture, and are not adapted to general farming. The topography is sometimes rough and unfavorable to cultivation.

Under intensive cultivation the soils having the more compact substratum are adapted to the culture of strawberries, brambleberries, potatoes, and early tree fruits and vegetables and are profitably utilized to some extent for these products. The gravelly sandy loams have, however, as yet been mapped to only a small extent. The cost of clearing the heavily timbered areas is excessive, but when placed under cultivation the soil requires only light farming equipment and can be effectively utilized in small, intensively cultivated tracts.

The gravel content renders the soils more porous and less retentive of moisture than the sandy loams, and they are thus less satisfactory for the production of any but the more intensively cultivated crops.

Everett gravelly sandy loam.—The soil consists of a light-brown to reddish-brown sandy loam, from 10 to 15 inches deep, containing rounded gravel ranging in size from small particles up to fragments 4 to 6 inches in diameter. It also contains a considerable quantity of small, rounded iron pellets, many of which are soft enough to crush between the fingers. These pellets have given rise to the local name of "shot clay land." The subsoil consists of a mass of glacial gravel embedded in a medium to coarse, gray sandy loam. The topography is gently rolling to rolling, becoming rough and broken in places near the foothills. The rolling topography and porosity of the subsoil make drainage excessive after the timber and the deep covering of forest litter have been removed, and very careful cultivation is necessary to conserve enough moisture for the successful growing of crops. The soil is not adapted to general farming, but must be utilized for the intensive cultivation of such crops as will give large returns from a small acreage. Potatoes and small fruits, especially strawberries, have proved profitable. When properly cared for, orchards also do well.

Spanaway gravelly sandy loam.—The soil consists of a dark-brown to black medium sandy loam about 12 inches deep, carrying a considerable quantity of gravel and small, rounded bowlders. The organic-matter content is high, giving the surface soil a somewhat silty texture. When cultivated the surface becomes lighter in color, often being a light brown. The subsoil consists chiefly

of rounded, water-worn rocks of all sizes up to 8 or 10 inches in diameter. It contains small quantities of coarse sands and fine gravel, but as a whole this type is characterized by the almost total absence of any fine material below the surface 18 inches. The soil occupies a broad, level to gently undulating plain, the most striking topographic features being the low, rounded mounds, shallow basins, and low terraces which form flat-topped embankments from 1 to 20 feet high. The coarse, porous character of the subsoil causes the natural drainage to be excessive, and it is only during the winter months when frequent rains occur that this soil retains sufficient moisture to keep the grasses and small vegetables in a green and growing condition. The soil is derived from the waters of melting glaciers, the swift currents having washed out nearly all of the finer material from the subsoil. The type is either treeless or supports a very sparse and stunted growth of timber.

Few attempts have been made at cultivation, the returns being insufficient to justify the expenditure of the time and labor necessary to produce a crop. Lack of sufficient moisture proves an effective bar to agriculture, except where irrigation waters are available. During the winter months it supports a fair growth of native grasses and is utilized for pasture land for sheep and other live stock.

Townsend gravelly sandy loam.—The soil consists of 10 to 12 inches of a black, fine sandy loam or loamy sand with a content of organic matter large enough to give it the appearance of a loam. The subsoil to an average depth of 3 feet is also a black fine sandy loam or sandy loam, slightly more sandy than the soil and having a lower organic matter content. At 2 to 4 feet the material changes abruptly into light colored, compact, gravelly sandy loam. When dry the subsoil may be broken down into a white powdery material, but in its original position or when saturated with water it is very impervious. Both soil and subsoil are mixed with stones and small glacial gravel. The type is of small agricultural importance.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Everett gravelly sandy loam	Washington 4, 5	1,351,296
Spanaway gravelly sandy loam	Washington 4, 5, 7	189,440
Townsend gravelly sandy loam	Washington 5	2,560
Total		1,543,296

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loams are of local occurrence and small extent and have been recognized in two soil series, each of which is represented only by the coarse sandy loam member. The surface material contains a large quantity of organic matter, which offsets somewhat the effect of coarse texture and porous structure, and improves the moisture-retaining powers of the soil.

The soils are, however, excessively drained. The topography is usually favorable to cultivation. In areas of less leachy and porous subsoils early tree fruits, small fruits, potatoes, and early vegetables are successfully grown. The remaining areas of the types are devoted to pasture.

The coarse sandy loams of the Glacial province are of comparatively little importance in the Pacific Coast region. They are best adapted to intensive agriculture, and require only a light farming equipment in cultivation.

Dallas coarse sandy loam.—The soil consists of a dark-brown to black, coarse sandy loam, about 12 inches deep, with a high content of organic matter. A few rounded glacial gravels and bowlders are sometimes found embedded in the soil or scattered over the surface. The subsoil is encountered at depths ranging from 12 to 36 inches, and consists of a compact mass of loamy sand and small gravel. The type is derived from thin glacial till, with an admixture of residual material from a substratum of metamorphic rocks. It occupies narrow benches or small plateaus found at the base of some of the higher hills and ridges. The limited acreage under cultivation produces very profitable yields of small fruits, potatoes, and vegetables. The small orchards located on this type do exceedingly well.

San Juan coarse sandy loam.—The soil to an average depth of 15 to 20 inches consists of a dark-brown to black, coarse sandy loam, well supplied with organic matter. In many places a considerable amount of coarse sand and fine gravel is found in the surface soil, but the relatively large proportion of organic matter present gives it, as a whole, a fine loamy texture. Glacial bowlders are often found scattered over the surface. The subsoil is coarser in texture and contains much less organic matter than the surface soil. It consists of a mass of gravel and small, rounded bowlders, embedded in a deposit of light-brown to gray loamy sand of medium to coarse texture. The type is treeless, but supports a fair growth of grasses and is utilized principally for pasture.

Area and distribution of the coarse sandy loams.

Soil name.	State or area.[1]	Acres.
Dallas coarse sandy loam	Washington 5	1,280
San Juan coarse sandy loam	do	768
Total		2,048

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loams are of extensive occurrence. They have been recognized in a number of soil series and constitute one of the more important soil groups of the Glacial province.

The topography is not usually favorable to cultivation. Drainage, as a rule, is thorough and sometimes excessive. Some of the members of the group have been developed for farming to a considerable extent; others are largely in forest or in a logged-off state, and used only for pasture or cultivated in small, cleared areas. The soil is friable under cultivation, and when once cleared requires only a light farming equipment, but the heavy forest growth makes clearing very expensive.

The purposes for which the soils are most suitable are governed largely by the character of the subsoil or substratum.

Where this is of loose, porous, leachy character the soils are usually deficient in power to hold moisture, and crops suffer during summer droughts. Potatoes and early truck, tree fruits, and small fruits, as a rule, can be successfully grown by means of intensive cultivation, and in favorable seasons moderate yields of grains may be obtained. Such areas are not, however, adapted to general farm crops and are best suited to intensive agriculture.

In the districts of less porous subsoils the fine sandy loams are well adapted to timothy, clover, oats, field peas, potatoes, and dairying, as well as to the more intensively cultivated fruits and vegetables.

The soils of the group are superior to those of the sandy loam group and its phases for general farming purposes and for most of the special products of small, intensively farmed tracts.

Clallam fine sandy loam.—The soil consists of a gray, loose fine sandy loam, about 12 inches deep. The surface 2 or 3 inches contains considerable organic matter which imparts a darker color than that found in the lower depths. The subsoil, to 26 inches, is a gray, slightly mottled fine sandy loam, with a high content of clay and silt, resting upon a yellowish-gray silty clay loam mottled with iron stains. In places iron pellets and glacial gravel are found in the soil. The type is of glacial origin. It is generally level to gently rolling, though all of it has sufficient slope to insure good surface drainage. It is well adapted to truck, fruit, blackberries, dewberries, strawberries, hay, and small grains.

Everett fine sandy loam.—The soil consists of 18 to 24 inches of light-brown to brown loamy fine sand, carrying considerable amounts of small, reddish-brown iron pellets. The subsoil is a light-brown to gray fine sand or loamy fine sand, sometimes of rather compact structure. Along the streams both soil and subsoil are usually of a considerably coarser texture and somewhat looser structure. Pockets and thin strata of coarse sand and gravel are frequently encountered below the third foot, giving the deeper subsoil a stratified

appearance. The soil is derived from deposits of glacial drift more or less stratified during the period of decomposition by the action of glacial waters. The topography varies from level to rolling. Rounded "kettle holes" are of frequent occurrence over parts of the type. On account of the topographic features and rather porous nature of the subsoil the drainage is usually excessive, though not so noticeably so as the coarser textured soils of the series. The greater part of the type has been logged, but only a small acreage is under cultivation. On parts of the type and under intensive methods of cultivation clover, hay, oats, small fruits, peas, potatoes, and other vegetables have been grown with good results. Strawberries have also proven a profitable crop.

Lynden fine sandy loam.—The soil consists of a light-brown to yellowish-brown fine sandy to silty loam, high in silt, and from 15 to 25 inches deep. It is underlain by a lighter-brown to gray fine sandy loam, similar in texture to the surface soil, but with a smaller organic matter content. A few gravel or small bowlders are in places found embedded in the soil or scattered over the surface. The topography is level to gently rolling, the type occupying the upper stream terraces and lower bench lands. Natural drainage is good, but not excessive, except on some of the slopes bordering the stream valleys. The soil represents an intermediate type between the Lynden sandy loam and the surrounding heavier and silty upland soils of glacial till. It is derived from the fine sand and silty sediments deposited by glacial waters. The type supports a heavy growth of timber and a dense undergrowth of ferns and other native vegetation. Oats, clover, timothy, vegetables, field peas, Irish potatoes, and fruits are successfully grown.

Spanaway fine sandy loam.—The soil consists of a dark-brown to black fine sandy loam, about 12 inches deep, containing a large amount of organic matter and in some places a small quantity of gravel. The subsoil to a depth of several feet is a grayish-brown, slightly loamy medium sand, becoming somewhat coarser in texture and lighter in color with depth. The topography is comparatively level and broken only by a few low mounds and ridges. Natural drainage is excessive and crops are apt to suffer from drought. The type is derived from deposits of sand laid down as sandbars or deltas by swift glacial streams emptying into the quiet waters which covered parts of the region during the glacial period. The greater part of this type is treeless, but a few small areas occur which support a sparse growth of timber. A large proportion of it is under cultivation. With proper methods for conserving the soil moisture fair yields of the various crops grown are obtained, especially during a wet season. Oats yield from 18 to 20 bushels and wheat from 8 to 10 bushels per acre. Potatoes, truck, and fruit are grown to some extent, and do fairly well when properly cultivated.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Everett fine sandy loam	Washington 5	72,960
Lynden fine sandy loam	Washington 4	19,904
Clallam fine sandy loam	Washington 5	4,096
Spanaway fine sandy loam	Washington 4	3,712
Total		100,672

[1] For key to numbers in this column see p. 733.

GRAVELLY FINE SANDY LOAM PHASE.

But one gravelly fine sandy loam type has been mapped so far in this province. It covers, however, extensive areas. It differs essentially from the fine sandy loam member of the same series in the greater content of gravelly material.

Only a small proportion of the type has been utilized for agriculture. Most of the area covered can only be cleared of timber and stumps at great expense, and a considerable proportion of the land is of rough, broken topography and unsuited to farming. Where cultivated the soil is friable, and does not require expensive or heavy farming equipment when once cleared. Oats, hay crops, potatoes, and fruits are the principal products.

The gravel content renders the soil of somewhat more porous character and less retentive of moisture than the fine sandy loams. Where recognized the type is underlain by a comparatively compact subsoil, is retentive of moisture, and subject to a somewhat heavier rainfall and to a less rapid loss of moisture through evaporation than is usually the case in the fine sandy loams. Climatic conditions favor the growth of native grasses, oats, and hay crops, and are well suited to dairying.

In relation to type of farming to which it is suited, the phase does not depart essentially from the fine sandy loam of the same series.

Clallam gravelly fine sandy loam.—The soil consists of a gray fine sandy loam, from 8 to 10 inches deep, containing a large amount of glacial gravel mixed with many small, reddish-brown iron concretions. The subsoil is a lighter-colored silty fine sandy loam, nearly white when wet. Glacial gravel and iron pellets occur in both soil and subsoil. The soil covers a large proportion of the area lying between the Olympic Mountains and the Straits of Juan de Fuca. It is derived from glacial drift material. The topography ranges from nearly level to rough and broken. Drainage is usually thorough and somewhat excessive over the rougher areas. Only a small proportion of the type is under cultivation. Much of it has been logged off, although considerable areas of timber remain. The soil is easily worked and holds moisture well if properly cultivated. The chief crops grown are hay, oats, and small quantities of potatoes and fruits.

Area and distribution of the gravelly fine sandy loam.

Soil name.	State or area.[1]	Acres.
Clallam gravelly fine sandy loam	Washington 5	96,256

[1] For key to number in this column see p. 733.

VERY FINE SANDY LOAM PHASE.

Types of this phase of the fine sandy loam group have been recognized only under one soil series. The soil differs from the fine sandy loam of the same series in the higher content of silty or very fine sandy material in both soil and subsoil and in the more compact and less pervious structure of the latter. The topography is comparatively flat or gently rolling. Surface drainage is fairly well established, although some local depressions of deficient drainage occur. Underdrainage is also rather deficient in spots, owing to the heavy, compact subsoil.

Only inextensive areas are at present utilized for farming purposes. The soil is forested, and clearing and preparing the land for cultivation is rather costly.

Owing to its finer texture and less porous structure the soil is more retentive of moisture than the fine sandy loams and gravelly fine sandy loams and is better adapted to the general farm crops, such as oats, clover, timothy, field peas, etc. The better drained areas are well suited to the production of vegetables, apples, brambleberries, plums, and other fruits. Early truck and fruit crops do better in the soils of lighter texture.

The soil is rather sticky when wet and is less easily maintained in a mellow, friable condition than the soils of the province previously described, except under favorable conditions of drainage. It requires a moderately heavy farming equipment and rather careful management.

In general relation to cultural practice and adaptation to crops it is allied more closely with the silt loams than with the members of the fine sandy loam group.

Clallam very fine sandy loam.—The soil consists of 12 to 20 inches of a gray to very light brown, silty fine sandy loam, the average depth being about 15 inches. The subsoil varies from a gray silty fine sandy loam of somewhat heavier texture than the soil, to a gray silty clay loam or silty clay. Yellowish-brown iron stains are of common occurrence below the second foot, producing a mottled appearance. A number of areas are found where the high silt content renders the soil sticky and adhesive when wet, the material resembling a light silt loam. The soil is of glacial origin. The type occurs as level to gently

rolling flats or plateaus and has fairly good drainage, though some areas could be improved by the use of tile. Very little of the type is under cultivation. When properly handled oats, clovers, peas and vegetables, apples, plums, and berries should prove profitable crops. Under irrigation alfalfa and other crops should do well.

Area and distribution of the very fine sandy loam.

Soil name.	State or area.[1]	Acres.
Clallam very fine sandy loam	Washington 5	11,520

[1] For key to number in this column see p. 733.

LOAM GROUP.

The soils of the loam group are not as extensive as those occurring under the fine sandy loam group or some of the phases of the sandy loam soils.

The virgin tracts support a heavy forest growth, which in some cases has been logged off or burned over. The cost of clearing even areas from which the merchantable timber has been cut is high. The topography is usually favorable to the practice of agriculture. Surface drainage of the larger areas is well established, although deficient in some of the less extensive members of the group.

The soil material is friable under cultivation, except in local areas of deficient drainage, the soils being readily maintained in good tilth and retentive of moisture. The subsoils are of rather fine texture and of more compact structure than the soils of the sandy loam and fine sandy loam groups.

When cleared the soils of this group require only a moderately heavy farming equipment and constitute one of the more promising groups of the Glacial province. They are well suited to general farming, and under favorable conditions as to markets and transportation can be profitably utilized in small tracts for the production of intensively cultivated crops. Potatoes, bramble and late tree fruits, hops, and the later staple vegetables can be successfully grown, while oats, clover, timothy hay, field peas, and forage crops give good yields. Dairying can also be practiced over suitable areas.

They are in general adapted to a somewhat heavier grade of general farming than the soils of the fine sandy loam group. While the soils are not so well adapted to early fruit or vegetable products as the soils of lighter texture, yields of later-maturing crops are larger and more certain.

Buckley loam.—The soil varies in depth from 8 to 12 inches and consists of a silty loam to a loam, dark brown to black in color as the result of the accumulation of organic matter. A small amount of coarse sand or fine gravel is occasionally found in the soil, but not in sufficient quantity to influence the texture. The subsoil is a dark or bluish-gray, impervious loam mottled with yellow or brown iron stains, and containing considerable coarse sand and fine gravel mixed with more or less angular and subangular rock fragments and small glacial bowlders. The soil is derived from deposits of glacial till. The uncleared land supports a heavy growth of fir, cedar, spruce, and alder, and a dense undergrowth of other vegetation. The type occupies extensive flat or very gently undulating areas, frequently bordered by steep slopes or bluffs, occurring as bench lands or almost level upland plateaus. Owing to the level topography and impervious nature of the subsoil, the natural drainage is poor, and ditching or tiling is usually necessary on the cultivated land. Where properly drained the soil becomes light and friable and is easily cultivated. It is well adapted to hops, clover, timothy, oats, potatoes, small fruits, and late tree fruits.

Everett loam.—The soil consists of a grayish-brown to light reddish brown heavy loam or silty loam about 12 inches deep. The surface when wet is dark gray, but when dry assumes a light ashy gray appearance. The subsoil is a light-drab to gray, heavy, silty loam, lighter in color than the soil. Strata of lighter textured, sandier material are often found in the subsoil. The soil contains very few bowlders or gravel. The topography is rolling. The type occupies the gentle slopes which form the foothills of the mountainous region, although comparatively level areas occur at intervals on the higher lands and plateaus. Drainage is good, but not excessive like that of the other soils of

the series. Only a small proportion of the type is under cultivation to timothy and clover, fruits, potatoes, and vegetables, the greater part being covered by a heavy growth of timber.

Orting loam.—The soil consists of a dark-drab to dark-brown sticky loam, from 8 to 12 inches deep, containing sand and small gravel. The organic matter content is high, and in some of the shallow depressions the surface has many of the characteristics of Muck. The subsoil is a gray to grayish-brown sandy loam or loam from 8 to 12 inches deep, slightly mottled with yellow, carrying coarse to medium sand, gravel, small rock fragments, and glacial bowlders. It contains enough silt and clay to make it decidedly sticky when wet. In position and surface indications the type resembles the more recent alluvial deposits, although the intermixture of coarse sand and fine material indicates glacial origin of the soil material. The lack of stratification and the assortment of the soil particles point clearly to an absence of modification by the assorting action of waters. The surface topography varies from level to gently undulating. The type occupies broad, comparatively level valleys almost surrounded by uplands and traversed by streams. Natural drainage, as a whole, is good, but artificial drainage is necessary in some of the shallow depressions. The native vegetation consists of fir, spruce, cedar, and alder. Hops do well on this soil and were once the main crop grown. Oats, potatoes, and hay are also grown and produce very profitable yields. Fruits and vegetables do well.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Buckley loam	Washington 4	27,904
Everett loam	do	21,632
Orting loam	do	4,480
Total		54,016

[1] For key to number in this column see p. 733.

STONY LOAM PHASE.

The stony loam of the Glacial province, recognized under only one soil series, is prevailingly of rough, hilly, or mountainous topography and for the most part unsuitable to the economical use of farm machinery. It is generally heavily forested, and when cleared of timber the cost of removing stumps, stones, and undergrowth, and preparing the land for cultivation is high. Most of the areas are poorly provided with roads or transportation facilities, and the less broken and more desirable areas are often comparatively inaccessible. The soil is of porous character, excessively drained, and subject to drought.

The type is of minor agricultural importance and is best adapted to pasture or left in forestry.

Everett stony loam.—The soil varies in depth from 10 to 15 inches and in texture from a light loam to silty loam. Gravel and small glacial bowlders are found scattered over the surface and mixed with the soil, frequently in sufficient quantity to make cultivation difficult. On the more level bench land the soil is deeper and more silty in texture, while on the steeper slopes it is more sandy in texture and contains a higher percentage of sand, rock, and gravel. The subsoil is a heavy sandy loam or loam containing a large quantity of gravel, small stones, and bowlders. The gravel in the deeper subsoil often occurs in irregular bands with occasional pockets of heavy, silty glacial till comparatively free from stones or gravel. The topography is rough and broken, the type occupying the mountainous regions forming the western border of the Cascade Range. This soil supports a dense growth of timber and underbrush. Its rough topography makes the greater proportion of the type of little or no agricultural value. Small, level bench lands or plateaus occur which could be used for agriculture, but they are limited in extent and the topography of the surrounding country is so rough that they are usually almost inaccessible. Where the timber is removed and the soil is cleared for agriculture, the natural drainage is excessive and both the soil and the subsoil remain in a dry condition during the summer months.

Area and distribution of the stony loam.

Soil name.	State or area.[1]	Acres.
Everett stony loam	Washington 4, 5	622,208

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam, like the stony loam phase of the loam group, is in this province confined to a single soil type.

It differs from the stony loam in topography, which is comparatively level to rolling and usually of such a character as to permit the use of farm machinery. It is more accessible and favorably located and lacks the excessive content of large cobbles and bowlders. It contains a large quantity of gravel, however, which is sometimes sufficient to impede cultivation. The soil is well drained, porous, and not retentive of moisture except where aided by intensive cultivation. Early tree fruits, small fruits, potatoes, and vegetables are the most promising products.

The soil is not well adapted to general farming, and in utilization and character of equipment required is related to the soils one or two grades lighter in texture than the normal members of the loam group.

Lynden gravelly loam.—The soil consists of a light-brown loam or silty loam, about 10 inches deep, containing a large quantity of rounded glacial gravel. The material varies from coarse sand to rounded cobbles several inches in diameter, but is principally medium-sized gravel, with a few small bowlders scattered over the surface. The subsoil consists of a stratified mass of fine and coarse gravel and small rounded cobbles. The interstitial material consists of sand, varying in texture from fine to coarse, with the coarser grades predominating. The gravel beds often occur in layers or beds from 2 to 10 feet thick, and are sometimes separated by thin strata of sand. The topography is generally rolling, with more or less extensive upland areas of comparatively level plateaus or terraces. The natural drainage of the type is thorough, and crops usually suffer from lack of moisture during the growing season. The soil is derived from the coarser glacial deposits of sand and gravel, the structure of which seems to indicate that they were laid down by flood waters as glacial outwash material. The coarser material was later covered by a very shallow deposit of glacial drift, which forms the finer material in the surface soil. The soil is fairly well adapted to the growing of fruits, and the acreage devoted to orchards is increasing. The gravelly texture of the soil makes its cultivation difficult, although fair yields of potatoes and vegetables have been secured on areas having a comparatively small amount of gravel in the surface soil.

Area and distribution of the gravelly loam.

Soil name.	State or area.[1]	Acres.
Lynden gravelly loam	Washington 4	20,928

[1] For key to number in this column see p. 733.

SILT LOAM GROUP.

The silt loams are confined mainly to certain portions of the area included within the glacial province, and include some of the most promising soils of the region. Various members of the group have been developed to some extent for farming, while others are almost entirely unutilized. They are usually heavily forested, and clearing the land for agriculture even after removal of the merchantable timber is expensive. The topography varies from comparatively level to rolling, and is not generally so rough as to render the land unsuitable to cultivation. Drainage is well established, although local areas of deficient drainage frequently occur in the majority of the soil types.

The soils are usually rather sticky when wet, but under favorable conditions of drainage and management are friable and easily cultivated with an average farming equipment. The subsoils are predominantly compact and retentive of moisture, though in one of the members of the group they are of porous character, excessively drained, and subject to drought. Under favorable conditions of drainage, moisture supply, and tillage they are usually well adapted to general farm crops and dairying, to bramble fruits, and the later or heavier vegetables, such as cabbage, cauliflower, onions, and root crops. Tree fruits, consisting of apples, plums, etc., are generally successful under favorable conditions of exposure and drainage. Climatic conditions are well suited to dairying and to the production of oats, clover, timothy, field peas, and other forage crops.

The more porous and thoroughly drained areas are not so well adapted to general farming but are suitable for the production of orchard crops, strawberries and brambleberries, and vegetables.

In general type of farming and of crops to which the soils of the silt loam group are adapted, they compare quite closely with those of the loam group.

Clallam silt loam.—The soil consists of a gray to drab silt loam about 10 inches deep, containing small amounts of sand and fine gravel. The subsoil to a depth of 36 inches consists of a gray, compact silty clay or silty clay loam. The type is derived from glacial drift and carries a few small glacial bowlders in both soil and subsoil. It occupies level to gently rolling benches near the base of gently rolling uplands. The natural drainage is generally good, though the more level areas would be improved by the use of tile. None of the type is cleared. Under a system of thorough cultivation it should be well adapted to general farm crops.

Everett silt loam.—The soil consists of 12 to 15 inches of a grayish-brown to light-brown silt loam with a high content of reddish-brown iron concretions. The dry surface has an ashy-gray color which becomes light brown when wet. In the latter condition it is sometimes rather compact and contains sufficient clay to make it sticky. The subsoil is a compact, gray silt loam or silty clay loam frequently marked with reddish-yellow iron stains. At 2 to 5 feet pockets of sand of various grades are occasionally encountered embedded in the silt, which are in turn underlain by coarser sands resting on a bed of gravel. The surface is level to gently rolling, and except for depressions and flat areas the drainage is fairly good, but in no case excessive, as is generally the case with other members of this series. Only a small proportion of the type is under cultivation, though much of it has been logged off. It is one of the best upland soils in the area. The chief crops grown are clover, oats, and fruit.

Lynden silt loam.—The soil consists of a light-brown to reddish-brown silt loam from 15 to 20 inches deep, containing considerable organic matter. Some fine gravel, coarse sand particles, and small iron concretions or pellets are sometimes found in the soil, but not in sufficient quantities to influence its fine, silty texture. The subsoil consists of a compact mass of sands and gravel. The sand varies in texture from fine to coarse, while the gravel is rounded and varies in size from coarse sand particles to small, rounded bowlders. The topography is rolling, with low, rounded hills, and extensive, comparatively level upland plateaus. Natural drainage is good and in some areas excessive. The soil is derived from glacial till of fine sand and silt or from outwash sediments laid down over coarse glacial outwash deposits of sand and gravel. The type supports a heavy growth of fir, cedar, and hemlock. The soil is well adapted to fruit growing and supports many small orchards. Small fruits, especially strawberries, do well, particularly during a season of plentiful rainfall. Both clover and timothy are grown to a limited extent, and while the yields are not as large as on some other types the quality of the hay is good. Irish potatoes produce good yields and vegetables do well, especially in a wet season.

Whatcom silt loam.—The soil is a brown to reddish-brown silt loam 15 inches deep, underlain by a compact, massive, drab or gray heavy loam or silt loam extending to a depth of 36 inches or more. Some gravel and small glacial bowlders are present. The type occupies a rolling country with low, rounded hills. Drainage is good, except where small, shallow, kettlelike depressions occur. It is of glacial origin. Practically all the area of this type is forested with a heavy growth of fir, cedar, and hemlock. Where cleared it is cultivated intensively to fruits, vegetables, and berries with excellent results. It is also suited to general farming.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Whatcom silt loam	Washington 4, 5	142,016
Everett silt loam	Washington 5	36,864
Lynden silt loam	Washington 4	22,144
Clallam silt loam	Washington 5	512
Total		201,536

[1] For key to numbers in this column see p. 733.

Clay Group.

SILTY CLAY PHASE.

This phase includes the soils of the Glacial province of clay texture, containing in addition a sufficiently large amount of silt to influence the soil in its adaptation to agriculture. While heavy and of high water-holding capacity, the soil possesses the smooth texture of the silt loams, and is usually more friable under cultivation than those of normal clay texture.

In this province the silty clays occur under two series, each of which is represented only by the silty clay member, which constitute the heaviest soils yet recognized in the Glacial province.

The topography is comparatively level to gently undulating and favorable to cultivation. Drainage is fairly well established, but sometimes locally deficient. The subsoil is of heavy, compact character and retentive of moisture.

The silty clay loams are sticky when wet and require rather thorough cultivation and careful management. Under favorable moisture conditions they can be worked without great difficulty, but require heavy farming equipment. They are adapted to a heavy type of farming, and are usually devoted to crops of hay, grain, and dairy products. The later vegetables, most of the tree fruits, and small fruits may by careful management and a careful selection of sites be grown for home use.

Salkum silty clay.—The soil consists of a brown to reddish-brown silty clay from 10 to 14 inches deep, underlain by a compact, reddish-brown silty clay. In local areas of poor drainage the soil frequently assumes a dark-brown color, the subsoil grading into yellowish brown or showing mottlings of yellow and gray. A deposit of weathered basaltic and andesitic glacial gravel underlies the type to a considerable depth. The type occupies old eroded terraces varying in topography from nearly level to gently rolling. The type as a whole is of friable character under cultivation, and it is well drained, friable, and retains moisture well, but a few of the more level areas or shallow depressions would be improved by artificial drainage. It is well adapted to grains and grasses.

Winlock silty clay.—The soil to an average depth of about 12 inches consists of a dark-gray to black, friable silty clay. This is underlain to a depth of 36 inches by a brown, dark-brown, or mottled gray and yellowish-brown silty clay. At an average depth of 4 to 10 feet the soil material is underlain by a compact mass of partially decomposed basaltic gravel and cobbles. The type occupies old glacial terraces, and has a level to gently rolling topography. The natural drainage is fair, except on a few of the more level areas or in slight depressions, which remain in a wet condition until late in the spring or summer. In these areas the restricted drainage has resulted in the accumulation of a large amount of organic matter, and the soil is of rather refractory character. As a whole the type is highly esteemed for general farming and the production of hay and grains.

Area and distribution of the silty clays.

Soil name.	State or area.[1]	Acres.
Salkum silty clay	Washington 7	141,568
Winlock silty clay	do	25,088
Total		166,656

[1] For key to number in this column see p. 733.

LAKE-LAID MATERIAL.

The soils derived from lake-laid material are encountered most frequently in the humid regions of the Northwestern States, where they occupy local glacial lake basins, depressions in river flood plains or terraces, or poorly drained and obstructed valleys of minor streams. They are mainly derived from eroded material of upland glacial soils deposited in shallow water. The individual areas are of limited extent and generally poorly drained. Much of the areas covered are uncleared of native timber or swamp growth, and utilized only for grazing. When drained they are usually suitable for the production of hay crops, potatoes, and small fruits and vegetables.

In the more southern semiarid and arid districts the province includes limited areas of soils not yet mapped, deposited in the waters of local closed drainage basins. These areas frequently contain injurious accumulations of alkali salts, are poorly drained or subject to periodical inundation, and are not of great agricultural importance.

DESCRIPTION OF THE SOIL SERIES.

Bellingham series.—The soils vary from dark brown or drab to black in color and are high in organic matter. The deeper subsoil is mottled drab or light gray, usually compact and poorly drained, and contains occasional pockets of gravel or sand. The soil is of alluvial origin, derived mainly from material washed down from the uplands and deposited in the shallow basins and depressions during the period when they were covered by waters or shallow lakes. The soils occupy the shallow upland basins which occur at intervals throughout the glacial region of western Washington. Many of the basins are wholly surrounded by rolling hills and ridges. The drainage waters from the adjacent uplands keep them in a wet, poorly drained condition. The large amount of organic matter found in the soil owes its origin to the decay of a rank growth of swampy vegetation under poorly drained conditions. The members of this series seldom support any large timber growth, willows, alders, and grasses comprising the characteristic vegetation. When artificially drained cabbage, cauliflower, peas, beets, and potatoes can be grown.

Area and distribution of the soil of the Bellingham series.

Soil name.	State or area.[1]	Acres.
Bellingham silt soil	Washington 4, 5	108,224

[1] For key to numbers in this column see p. 733.

Custer series.—The soils are dark brown to black in color and the subsoils gray to brown. They comprise the sedimentary glacial basin soils, which are underlain by sandy material. The types have been formed by the gradual filling up of these basins by material washed from the surrounding glacial uplands. These soils occupy shallow basins which were formerly small lakes or ponds. The basins were covered originally by a deposit of sand, over which was deposited later the finer material, consisting mainly of fine sand, silt, and clay, which was laid down in the quiet waters of the lake or ponds. The subsoil contains a high percentage of iron, which frequently cements the sand into a compact mass. Small iron concretions and aggregates are of common occurrence throughout the soil mass, while beds of bog iron ore are occasionally encountered in the subsoil. The large amount of organic matter present in the soil is derived from the slow decay of the rank growth of swampy vegetation under poorly drained conditions. In some localities the surface soil is covered by a shallow deposit of Peat or Muck. The surface of these basins is level to gently undulating, and artificial drainage is necessary on all of the soils in the series before they can be profitably utilized for agriculture. When drained and well cultivated these soils are very productive. The principal crops grown are oats, hay, Canada field peas, and Irish potatoes. Vegetables and fruits and small fruits have also been grown to a limited extent.

Area and distribution of the soils of the Custer series.

Soil name.	State or area.[1]	Acres.
Custer loam	Washington 4	8,704
silt loam	do	8,960
Total		17,664

[1] For key to number in this column see p. 733.

Ebeys series.—The soils of this series are derived from glacial material eroded from upland glacial drift and outwash soils of the Everett series and redeposited in shallower water and at a higher elevation than the finer sediments of the soils of the Bellingham series, which often occupy lower depressions adjoining areas of this soil. The areas were probably at one time covered by the waters of glacial lakes or served as broad glacial channels emptying into the heads of small bays or inlets. The large amount of organic matter present in the soil is due to the decay of native vegetation under conditions of poor drainage. The topography is level to gently rolling and drainage usually well established. The soil is of dark to black color, carries much organic matter, and is underlain by a gray, sandy subsoil. Gravel is frequently present in both soil and subsoil. These soils are, as a rule, very productive.

Area and distribution of the soil of the Ebeys series.

Soil name.	State or area.[1]	Acres.
Ebeys sandy loam	Washington 5	4,864

[1] For key to number in this column see p. 733.

Tower series.—The soils are of dark-gray, drab, or black color and contain an excessive amount of organic matter, frequently rendering them of somewhat mucky character. The subsoils are yellowish brown or gray to drab, compact, and frequently mottled with red and yellow iron stains. Pockets of sand and gravel are of frequent occurrence. The series occupies small, shallow upland depressions or lake basins, often without outlet, and poorly drained valley flats occurring in areas of old elevated and eroded terrace deposits. They are frequently surrounded by areas of undulating to rolling topography and subject to drainage waters from surrounding soils. The surface varies from level to hummocky, and the soils are usually poorly drained and sparsely timbered or covered with shrubs and bushes. The soils are of lacustrine origin, having been deposited in shallow lakes or ponds or in poorly drained and flooded areas. The material is mainly nonglacial and principally of basaltic character and derived from adjacent residual soils or old terrace deposits. Where drained, these soils are productive and adapted to hay, oats, and potatoes. In general characteristics they resemble the Bellingham series occurring in the Northwestern glaciated regions.

Area and distribution of the soils of the Tower series.

Soil name.	State or area.[1]	Acres.
Tower fine sandy loam	Washington 7	1,536
clay loam	do	14,848
clay	do	768
Total		17,152

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sandy Loam Group.

Soils of sandy loam texture have been encountered under but one series of soils derived from lake-laid material. This series is represented solely by the sandy-loam type which is confined to the glaciated districts of the northern part of the Pacific Coast region.

The soil and subsoil material are of rather porous character and under droughty conditions not physically favorable to the retention of moisture. The soil, however, contains a large amount of organic matter, which improves its moisture-holding capacity and texture, and the type is well drained and favorably situated as regards moisture supply. Owing to these features, it is well adapted to general farming purposes as well as to the culture of potatoes, forage crops, and vegetables.

It is of limited extent, friable, and easily cultivated, and capable of being successfully tilled with light farming equipment.

The soil is usually better adapted, both by reason of physical characteristics and position with regard to the occurrence of frosts, to the growth of early and less hardy vegetables than are the other soils of this province.

Ebeys sandy loam.—The soil consists of 8 to 15 inches of a black sandy loam containing a large amount of organic matter. The subsoil to a depth of 36 inches is a gray, light, medium to fine sandy loam or loamy sand. One phase of this type carries large amounts of gravel in both soil and subsoil. The type has been formed by accumulations of organic matter and water-laid sediments overlying low-lying deposits of coarser glacial material.

Area and distribution of the sandy loam.

Soil name.	State or area.[1]	Acres.
Ebeys sandy loam	Washington 5	4,864

[1] For key to number in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loam soils of the Lake-laid province, in so far as recognized, are represented by a single soil type. Drainage is deficient over local areas, but generally fairly well established.

While of limited extent, the soil is of considerable local agricultural importance, and is utilized for dairying, hay and forage crops, and potatoes, and to a small extent for the production of vegetables and fruits, mainly for home use. It is friable, requires only an average farming equipment, and under favorable conditions of drainage and moisture supply is adapted to general farm crops, including clover, timothy, and forage crops, potatoes, and vegetables. It is somewhat better suited to general farming purposes and to dairying than the sandy loam of the province.

The culture of apples, pears, cherries, and small fruits can probably be profitably extended in areas of good drainage. Conditions are not quite so favorable for the production of early cherries or other stone fruits or of early vegetables as with soils of lighter texture and better developed drainage.

Tower fine sandy loam.—The soil is dark gray to black in color and from 10 to 15 inches deep, and contains a few small pockets of gravel. The subsoil is a light-brown loam or silty loam, often grading into a silty clay loam at a depth of 36 inches and resting upon a deposit of rounded gravel at depths of 4 to 6 feet. The type occupies broad basins almost entirely surrounded by rolling hills. The topography is uneven, broken by small, rounded elevations, with shallow basins intervening. Natural drainage is fairly good, although small areas would be improved by ditching or tiling.

The type is utilized mainly for the production of dairy products, oats, clover and timothy hay, kale, and other forage crops. Where well drained it is also suitable for potatoes, berries, truck crops, apples, pears, and cherries.

Area and distribution of the fine sandy loam.

Soil name.	State or area.[1]	Acres.
Tower fine sandy loam	Washington 7	1,536

[1] For key to number in this column see p. 733.

Loam Group.

Soils of the loam group in this province are of limited extent and have been recognized under only one soil series. Surface drainage is poorly established, though counteracted to some extent by the porous, permeable subsoil. Climatic and soil conditions favor the production of hay, oats, forage crops, and dairy products, but the cool, moist summers are unfavorable to the maturing of wheat.

The soil is friable under cultivation, but requires artificial drainage for its complete development. A moderately heavy farming equipment is necessary. It is adapted to general farming and dairying and when drained is suitable for the production of potatoes, cabbage, onions, cauliflower, and other of the later and heavier vegetables. Owing to physical characteristics of soil, poor drainage, and danger of frosts over the low-lying areas fruits or early and delicate truck crops do better on the fine sandy loams than on the loams.

Custer loam.—The soil consists of a dark-gray or dark-brown loam from 10 to 12 inches deep, silty in the first few inches, but becoming sandier as the subsoil is approached. The subsoil is a compact loamy sand becoming lighter and less loamy in the lower depths. Pockets of fine gravel and iron concretions are common in the subsoil. The type occupies level to gently undulating, low, poorly drained depressions. It is of glacial origin. Small cultivated areas produce fair yields of oats and hay. Where thoroughly drained the type will produce good crops of potatoes and other vegetables.

Area and distribution of the loam.

Soil name.	State or area.[1]	Acres.
Custer loam	Washington 4	8,704

[1] For key to number in this column see p. 733.

Silt Loam Group.

The silt loams are more frequently encountered and extensive than any of the other soil groups of this province.

Drainage is poorly established, and artificial means are usually necessary in the complete development of any areas of considerable extent. The soils contain a large amount of organic matter, which tends to improve the textural and structural features. They are usually sticky when wet, and under unfavorable conditions of drainage and cultivation are somewhat difficult to handle except under careful management. A rather heavy farming equipment is required for effective cultivation.

The soils are adapted mainly to dairying and to the growing of oats, hay, and forage crops, including field peas, kale, etc. Where drained and properly cultivated they are also well adapted to the commercial production of the later and heavier vegetables, including cabbage, cauliflower, onions, beets, and potatoes. Owing to the more frequent occurrence of frosts in the low-lying depressions usually occupied by the soils of this group fruits do not thrive.

The silt loams constitute excellent general farming soils, and in many portions of the areas in which they occur are extensively utilized both for this purpose and for truck farming. The cost of clearing and preparing the land for cultivation, aside from expense of draining, is usually much less than upon the more elevated types of the other soil provinces.

Bellingham silt loam.—The soil consists of a dark-brown to drab or black, heavy silt loam about 12 inches deep, underlain by a drab or mottled, heavy silt

loam, becoming heavier and more compact at a depth of 30 inches. The type represents material washed from neighboring uplands and deposited in shallow lakes and ponds, and occurs as gently undulating depressions or small basins. Natural drainage is poorly established. The type produces from 3 to 4 tons of hay per acre, and when tile drained is a fair soil for cabbage, cauliflower, peas, beets, and potatoes.

Custer silt loam.—The type consists of a gray to dark-drab silty loam from 15 to 20 inches deep, often mottled with yellow iron stains and underlain by a gray to brown, compact, loamy subsoil. Accumulations of organic matter are present in the surface soil, and iron concretions, gravel, and silty clay occur in small quantities throughout the soil profile. The type is derived from glacial lake sediments. It occupies level to slightly rolling, poorly drained depressions. Extensive artificial drainage has been necessary over areas now producing large yields of hay, oats, and peas, with truck and small fruit on the better drained portions.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Bellingham silt loam	Washington 4, 5	108,224
Custer silt loam	Washington 4	8,960
Total		117,184

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loam group in this province is confined to a single soil series. It is of frequent occurrence in the nonglaciated portions of western Washington, but usually occurs in small local bodies of minor agricultural importance.

Drainage is very poorly established, and considerable expense is necessary in preparing the land for agricultural purposes. The cost of removing the timber is not excessive.

Unless well drained and carefully managed, the soil is of refractory structure and requires heavy farm equipment for the successful conduct of tillage operations. Much of the area covered by the type is not utilized and the cultivated areas are as yet only imperfectly developed.

The soil is cold and late, being best adapted to dairying and to a heavy type of farming. Oats and hay crops are the principal products. Potatoes can be successfully grown on the well-drained areas.

It is not so well adapted to the culture of vegetables as the soils of the silt loam group.

Tower clay loam.—The soil consists of a dark-gray to grayish-brown, heavy clay loam, about 10 inches deep, and contains a large amount of organic matter. The subsoil is a clay loam or clay, compact and impervious when dry, and carrying thin strata of sand and gravel in the deeper portions. Poorly drained areas often contain accumulations of organic matter in the first 4 to 6 inches of soil. The topography is level to very gently undulating, while the low position of the soil and the impervious character of the subsoil cause the natural drainage to be very poor. Well-drained and properly cultivated areas are adapted to general farming and dairying. Oats and hay crops are the principal products, although the better drained areas are fairly well suited to potato culture.

Area and distribution of the clay loam.

Soil name.	State or area.[1]	Acres.
Tower clay loam	Washington 7	14,848

[1] For key to number in this column see p. 733.

Clay Group.

The soils of the clay group, which have been recognized under one soil series, resemble the clay loam in general conditions and extent.

Drainage is very poorly established and the soil is scarcely utilized for purposes other than pasture. Timber cover is usually displaced by swamp or marsh vegetation, willow, etc. The cost of clearing the land is moderate.

The soil is of heavy, tenacious character, and refractory under cultivation, requiring a heavy farming equipment for cultural operations.

Dairy products, hay, and grain crops give the best results, although in crop adaptation these soils do not differ materially from the clay loam group.

Tower clay.—The soil consists of a dark-gray, grayish-brown or drab, waxy, compact clay, from 10 to 15 inches deep, often mottled with iron stains. The subsoil is a stiff, compact clay, slightly lighter in color than the soil, and mottled with yellow or brown iron stains. The soil material often rests upon compact deposits of sand and gravel at a depth of 30 inches to 4 feet below the surface, and pockets of this coarse material are sometimes encountered in the subsoil. The topography is flat, the soil occupying basin-like depressions. Because of the compact subsoil, natural drainage is poor, and the basins remain in a wet condition during a larger part of the year. The type is difficult to handle except under proper moisture conditions. It is adapted to dairying and to hay crops and in the better drained areas to oats. The native vegetation consists of alders, willows, and swamp grass.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Tower clay	Washington 7	768

[1] For key to number in this column see p. 733.

WIND-LAID MATERIAL.

The soils derived from wind-laid material are of inextensive occurrence and of but little agricultural importance. Where mapped they are derived mainly from the sands of marine beach deposits drifted landward by winds. Ordinarily they are sparsely timbered or barren, are prevailingly of sandy texture and of porous structure, deficient in organic matter, and when cleared are readily wind blown. They are utilized only for grazing or for the production of vegetables for home use.

Other areas not yet surveyed occur in the wide, arid river valleys, the later alluvial deposits of which where unprotected by vegetation have subsequently been transported and redeposited by winds.

DESCRIPTION OF THE SOIL SERIES.

Westport series.—The soils extend to a depth of several feet and are of light yellowish gray to gray, mottled, or dark-brown color. Considerable organic matter is often present in the immediate surface, imparting a darker color. They are derived from beach sands subsequently drifted and transported by winds. Some portions are fairly level, but as a rule the topography is characterized by a series of long, narrow ridges from 10 to 40 feet high, with intermediate depressions very little above sea level. The native vegetation consists of a stunted growth of fir, alder, and cedar. The loose, porous nature of these soils makes drainage excessive, and crops suffer from drought.

Area and distribution of the soil of the Westport series.

Soil name.	State or area.[1]	Acres.
Westport fine sand	Washington 5, 7	27,904

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Fine Sand Group.

Only one member of the fine sand group has been recognized, being the sole representative of the province confined to soils of wind-laid origin of the Pacific Coast region.

This soil is of loose, porous structure, is subject to wind drifting when not protected by vegetation, and is of little agricultural importance. Light yields of vegetables, small fruits, or of grain and hay crops may be obtained for home use in favorable locations, but the soil is deficient in moisture-retaining capacity and often in organic or mineral plant food and is not in general suitable to agricultural development.

Westport fine sand.—The soil consists of a gray or mottled gray and brown fine sand, several feet in depth, so loose and incoherent as to be easily moved by the winds, unless protected by vegetation. The surface few inches are darkened by accumulations of organic matter. The more level areas and depressions could be utilized to a limited extent in growing truck crops, grain, and hay, but, as a whole, the type is unsuited to agriculture. Oats, wheat, and hay are grown to a limited extent, but the yields are light.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Westport fine sand	Washington 5, 7	27,904

[1] For key to numbers in this column see p. 733.

COASTAL PLAIN AND OLD VALLEY FILLING MATERIAL.

The Coastal Plain province of the Atlantic and Gulf coast is for the most part strongly differentiated from the surrounding soil provinces in that the assorting action of the ocean waves and currents is plainly apparent in the character and distribution of the soils; but on the Pacific coast, and particularly in the great valley—a former arm of the sea—wave and current action was much less pronounced in its effects on the character and distribution of the soil material, making it difficult to distinguish between those of marine origin and those representing old alluvial valley filling, much of which has lost the characteristic fan shape possessed by most of the recent valley material.

In a general way the soils are referred to the various groups of rocks from which the parent deposits were derived. These rocks include a wide range of geological material, embracing both quartz-free and quartz-bearing igneous and metamorphic rocks, as well as those of sedimentary origin. Frequently the mineral components of the soil have been derived from an admixture of minerals having their origin in a variety of rocks.

The soils of this group are subject to a wide range in climatic conditions, occurring in the most humid as well as the more arid regions of the United States. They also vary widely in topography, moisture-retaining capacity, and adaptability to irrigation.

In some of the lower lying members drainage is poorly established, but the greater part of the areas covered occur as gently sloping to undulating terraces and valley plains.

Some of the true marine deposits are of recent deposition, modified by wind action. The soils derived from the older marine terraces and valley filling are generally well weathered, are characterized by red or reddish-brown color in the soil or subsoil material, and by the occurrence of heavy, compact subsoils, frequently with an absence of iron cemented hardpan.

The soils of this group occur most extensively in the great interior valley of California, and to a less extent in Oregon and Washington. In the latter two States they are, where mapped, not extensively utilized, but in California they comprise large areas of the principal grain-producing lands of the Coastal Plain. Where capable of irrigation and free from hardpan at shallow depths they are here adapted to a wide variety of special fruit crops, particularly peaches, table and wine grapes, strawberries, and other small fruits.

The soils are frequently rendered more suitable for deep-rooted deciduous and citrus fruit crops by blasting the underlying hardpan substratum where this occurs.

DESCRIPTION OF THE SOIL SERIES.

Alamo series.—The Alamo series consists of dark reddish brown to dark-drab or black soils underlain at depths ranging from 15 inches to 5 feet by a red or grayish-red, mottled iron hardpan. They are derived mainly from the soils of the San Joaquin series and are formed of the Pleistocene sediments constituting this series subsequently modified by extensive and periodical overflows with the resulting accretion of finer river sediments and organic matter. They occupy the lower lying, flat plains and basins of deficient drainage, frequently marked by intermittent lakes, sloughs, and in places by the occurrence of swamp vegetation. They are usually treeless, except for a few willows in the vicinity of stream courses. The soils of this series are devoted principally to grazing or to grains, and, on account of their position, liability to overflow, and poor drainage conditions, are often cultivated with difficulty.

Area and distribution of the soils of the Alamo series.

Soil name.	State or area.[1]	Acres.
Alamo clay loam adobe	California 12	18,368
clay adobe	California 12, 18	32,000
Total		50,368

[1] For key to numbers in this column see p. 733.

Arago series.—The soils are prevailingly of light-brown color, compact but friable under favorable moisture conditions, and about 15 inches deep. The subsoils range from brown to light brown in color and are rather heavy and compact, usually resting upon shale, sandstone, or upon gravel beds, outcrops of which sometimes occur. The soil material consists of water-laid marine and estuarine deposits of a former period of submergence, mixed with later superficial colluvial and alluvial material derived from adjacent slopes, much of the original terrace material having been removed by erosion. The series occupies valley slopes and remnants of elevated terraces. Drainage is usually well established. The soils are heavily timbered, and while inextensively developed are adapted to the production of grain and hay crops, dairying, bramble, and other small fruits, and apples.

Area and distribution of the soil of the Arago series.

Soil name.	State or area.[1]	Acres.
Arago clay loam	Oregon 3	8,320

[1] For key to number in this column see p. 733.

Blacklock series.—The soils are dark ashen gray to brown or bluish black in color, often containing considerable organic matter and becoming almost black when wet. They are underlain by heavy, dark-colored subsoils to a depth of 3 feet or more, the deeper portions consisting of reddish-brown to dark-brown or dark-gray sandy material, often containing ferruginous hardpan strata or small, shotlike pellets similar to that occurring in the subsoils of the Empire series. The types occur as flat to gently sloping Coastal Plain deposits occupying heavily forested to sparsely timbered low plains near coastal beaches or elevated marine terraces. They are marked by the frequent occurrence of low, shallow, poorly drained depressions filled with swamp vegetation. They represent shore deposits derived mainly from sandstone and shale rocks of the Coast Range Mountains, transported and modified by waves and marine currents, with frequent additions of the finer wash material from adjacent hill slopes or supplied by flood waters of minor streams and by the

incorporation of organic matter resulting from decaying swamp vegetation. The greater part are uncleared at the present time.

Area and distribution of the soils of the Blacklock series.

Soil name.	State or area.[1]	Acres.
Blacklock sandy loam	Oregon 3	4,864
loam	do	4,480
clay	do	4,864
Total		14,208

[1] For key to number in this column see p. 733.

Copalis series.—The soils are of yellowish-brown to dark-brown color, silty texture, and usually of high organic matter content. The subsoils are light brown, mottled with yellow and gray, compact and heavy, and underlain at 2 to 5 feet by compact but loosely cemented gravel similar to that underlying the Hoquiam series. The gravels are often stained by iron or manganese oxide or by carbonaceous material. The soils are derived from old, partially indurated or consolidated sedimentary deposits formed mainly from shales and sandstones, but including some basaltic and quartz material. They occupy old marine or valley terraces which were probably elevated during Pleistocene times, ranging in elevation from 20 to 50 feet above the present stream channels. The topography is level to gently rolling, the slopes usually being sufficient to insure good drainage, though many poorly drained depressions occur. The greater part of these soils are still timbered with fir, spruce, cedar, and hemlock. The timber growth is inferior to that of the Hoquiam soils.

Area and distribution of the soil of the Copalis series.

Soil name.	State or area.[1]	Acres.
Copalis clay loam	Washington 5	23,808

[1] For key to number in this column see p. 733.

Corning series.—The soils are of reddish-brown or red to deep-red color, rather shallow, easily puddled, and hard to handle except under proper moisture conditions. The subsoils are reddish brown to deep red, of heavy and compact structure, and impervious to moisture. The soil material is derived from Quaternary sedimentary deposits of the Red Bluff formation, constituting elevated terraces or remnants of an older valley filling, which have, however, been somewhat altered or reworked. The soils occupy sloping to undulating or hilly and dissected upland terraces and valley plains. The surface is frequently marked by "hog wallows," depressions, and local poorly drained areas. The members of this series are usually treeless. In origin and mode of formation, color, character of soil and subsoil, and topographic features the soils resemble the Redding series. The underlying hardpan, however, of the Redding series is, in the Corning series, either wanting or of soft and more or less permeable character. The soil material is also generally somewhat deeper than that of the Redding series. The soils of this series are poorly adapted to general farming and to tree fruits.

Area and distribution of the soils of the Corning series.

Soil name.	State or area.[1]	Acres.
Corning fine sandy loam	California 2	1,920
loam	California 2, 16	84,224
gravelly loam	do	32,128
Total		118,272

[1] For key to number in this column see p. 733.

Empire series.—The soils are gray to reddish brown and from 10 to 20 inches deep, the surface material often containing a large amount of organic matter, imparting a dark color and silty texture to the first few inches. They are underlain by sandy subsoils of gray to reddish-brown color, the gray and brown colors often appearing in alternate strata, frequently carrying small iron-cemented pellets or marked by the occurrence of thin layers of ferruginous hardpan. The members of this series occur as Coastal Plain sediments deposited and modified by waves and shore currents, the material having been derived principally from the sedimentary rocks of the Coast Range, but to some extent from altered and eruptive rocks, and transported to the sea by streams. The deposits have been subject to more or less modification since their formation through addition and admixture of finer material washed from adjacent slopes and by action of the wind. The soils of the series are generally heavily forested and occur as low to elevated coastal plains of gently sloping to undulating surface, in some places marked by dunes and wind-blown ridges. They are still largely in forest or used for grazing, and are of little present importance as farming land. The lighter soils are best adapted to forestry. The soils of medium and heavy texture could be used for the production of berries and other small fruits, certain orchard fruits, and in some cases for grain and hay crops.

Area and distribution of the soils of the Empire series.

Soil name.	State or area.[1]	Acres.
Empire fine sand	Oregon 3	5,248
fine sandy loam	do	19,200
clay loam	do	18,112
Total		42,560

[1] For key to number in this column see p. 733.

Hesson series.—The soils are dark reddish brown, and underlain by yellowish-brown to reddish-brown subsoils of compact structure. Rounded gravel and small bowlders of quartzite or basaltic rocks are of frequent occurrence on the surface and occasionally occur in the soil and subsoil, being most numerous along the steeper slopes. The series occupies eroded terraces of undulating to rolling topography, usually elevated several hundred feet above the present valley bottoms. The material has been derived mainly from basaltic rocks, and consists of old alluvial or possibly marine terrace deposits. The soils are well drained, retentive of moisture, and originally were heavily forested with fir and hemlock. They are well adapted to general farming and orchard fruits.

Area and distribution of the soil of the Hesson series.

Soil name.	State or area.[1]	Acres.
Hesson clay loam	Washington 7	37,888

[1] For key to number in this column see p. 733.

Hoquiam series.—The soils are reddish brown to red, from 12 to 15 inches deep, and underlain by compact subsoils of the same color as the soil and resting upon loosely cemented sandstone, basaltic, quartz, and shale gravel at depths ranging from 3 to 10 feet.

The series is derived from beds of gravel or conglomerates, clays, and soft arenaceous shales and some basalt, and represent marine sediments laid down in shallow waters. These beds were elevated during Pleistocene time, and have been but partially indurated and consolidated. The sediments are soft, and as a result erosion has been very rapid on the steeper slopes. The topography is rolling to hilly, the slopes being less pronounced than on the Melbourne soils. Drainage is well established, except over small depressions, and cultivation is possible except on the steeper slopes. The original forest growth consists of fir, spruce, cedar, and hemlock. Some large tracts have been cut over, but at present practically none of the series is under cultivation.

Area and distribution of the soil of the Hoquiam series.

Soil name.	State or area.[1]	Acres.
Hoquiam clay loam	Washington 5	204,800

[1] For key to number in this column see p. 733.

Madera series.—The soils range in color from light to dark reddish brown, are generally sticky when wet, readily puddled, and compact and hard when dry. They are underlain by reddish, ferruginous indurated clay or sandy hardpan, at depths ranging from 2 to 4 feet, with frequent outcrops. The hardpan layer is usually fissile in character, and carries calcareous incrustations on the surface and in the crevices. The material is derived from old Pleistocene deposits, represented by the San Joaquin series, and in the Madera series subjected to more advanced weathering and modified by alluvial material from intermittent streams. The soils occupy level or sloping to undulating treeless plains, often containing "hog wallows," the level areas and depressions being poorly drained. The soils of this series are devoted mainly to the production of dry-farmed grains or to grazing, but under favorable conditions of irrigation and drainage are adapted to much the same character of crops as the soils of the San Joaquin series.

Area and distribution of the soils of the Madera series.

Soil name.	State or area.[1]	Acres.
Madera sand	California 11	8,640
coarse sand	do	7,168
sandy loam	do	74,368
fine sandy loam	do	1,152
clay loam	do	2,048
Total		93,376

[1] For key to number in this column see p. 733.

Montesano series.—The soils are of dark to black color, carrying a high percentage of organic matter, and have a depth of 12 to 24 inches. The subsoils are mottled gray, yellow, or brown, and underlain at less than 3 feet by compact sand, gravel, and clay. The soils occur as benches along streams or as depressions in more rolling areas of other soils. The soil material has been modified to a considerable extent by large accumulations of organic matter. Owing to the impervious nature of the subsoil, the depressed areas are often deficient in natural drainage. They are derived from a compact, partially consolidated mass of sands, clays, and beach gravels, probably elevated during Pleistocene times. The gravels consist chiefly of rounded impure sandstones, with basalt, shale, and quartz gravels in varying quantities.

With the exception of level, mucky areas or of treeless prairies of restricted drainage, the soils of the series are forested with a rather stunted but dense

growth of cedar, spruce, fir, and pine. They are adapted to hay crops, oats, potatoes, and in some cases to fruit.

Area and distribution of the soils of the Montesano series.

Soil name.	State or area.[1]	Acres.
Montesano silty clay loam	Washington 5	13,056
clay loam	do	4,096
Total		17,152

[1] For key to number in this column see p. 733.

Pleasanton series.—The soils are reddish brown to red, and often carry rounded to subangular gravel and cobblestones. The subsoils are red to yellowish brown, often mottled with gray, and of heavy, compact character. Beneath this there is nearly always a layer of very gravelly clay loam. The series is derived from old sedimentary deposits composed of clay, silt, and gravel, probably of Pleistocene age. The topography ranges from undulating or gently rolling to very hilly and dissected. Except in areas of the heavier soils, the drainage is inclined to be excessive. The soils are free from alkali. They are practically treeless or support a few field oaks. They are usually droughty and not well suited for irrigation. Wide areas covered by the survey are used for grazing. The more level areas are dry-farmed. Hay, grain, and grapes are the chief products.

Area and distribution of the soils of the Pleasanton series.

Soil name.	State or area.[1]	Acres.
Pleasanton sandy loam	California 8	3,008
gravelly sandy loam	do	8,960
loam	do	13,120
gravelly clay loam	do	832
clay adobe	do	5,568
Total		31,488

[1] For key to number in this column see p. 733.

Redding series.—The soils range from reddish gray to deep red, are usually gravelly, and sometimes carry large amounts of alkali and partially indurated clay-iron hardpan. They are derived from the Red Bluff formation, consisting of early Quaternary alluvial valley deposits, and occupy valley plains or terraces, usually well elevated above present stream valleys and often dissected or eroded. The surface varies from nearly flat or gently sloping to undulating or rolling. Surface drainage is usually well established, but underdrainage is checked by the impervious subsoils and hardpan. The more elevated areas usually support a growth of oaks, scrub pines, and manzanita or other scrubby trees and bushes. Where there is not an excess of cobbles, or where not underlain at shallow depths by hardpan, the soils are well adapted to the production of choice peaches and small fruits. The shallow areas are not suited to prunes or other deep-rooted trees. Strawberries and bramble fruits yield abundantly, and if irrigated the shallower soils not adapted to tree fruits could be utilized for these small fruits. Where irrigation is not practicable the soils are used principally for grazing or for the production of dry-farmed wheat.

Area and distribution of the soils of the Redding series.

Soil name.	State or area.[1]	Acres.
Redding gravelly sandy loam	California 16	5,504
loam	California 16, 17	25,728
gravelly loam	California 17	57,216
Total		88,448

[1] For key to numbers in this column see p. 733.

San Joaquin series.—The soils are prevailingly red and frequently gravelly; both the finer soil particles and gravel are rounded. The soils are underlain at depths ranging from 2 to 3 feet by red or mottled indurated clay or sandy layers, and sometimes by gravel and cobbles cemented by iron salts into a dense impenetrable hardpan which occasionally outcrops at the surface. The soils are generally of compact structure, sticky, quite readily puddled when wet, and frequently separated from the underlying hardpan by subsoils of true adobe structure. They consist of sediments of early Pleistocene age, sometimes modified by more recent reworking or by alluvium washed from adjacent formations. They occupy level to undulating or rolling valley plains extending from lower rolling foothills down to level valley floors and margins of present stream flood plains. The soils are usually treeless, except in the immediate vicinity of stream channels. Natural drainage is restricted by topographic position, deficient slope, and the presence of hardpan, except in the case of lighter, deeper members and areas occupying higher slopes. The soils of this series are generally devoted to dry-farmed grains, but the lighter, deeper, and better drained types are sometimes used for the production of citrus and stone fruits, figs, grapes, small fruits, and truck crops. Where properly drained and irrigated they give excellent yields. The heavier members are frequently marked by an adobe-like structure. The soil, subsoils, and hardpan are usually free from alkali.

Area and distribution of the soils of the San Joaquin series.

Soil name.	State or area.[1]	Acres.
San Joaquin sand	California 3, 18	45,696
sandy loam	California 3, 11, 12, 13, 15, 18, 23	642,163
gravelly sandy loam	California 11	1,152
sandy loam adobe	California 3	12,691
fine sandy loam	California 12, 18	35,200
loam	California 12, 13, 23	93,504
gravelly loam	California 12	22,848
clay loam	California 11, 15	24,512
clay adobe	California 15, 18	5,760
Total		883,526

[1] For key to numbers in this column see p. 733.

Tuscan series.—The soils are reddish brown, of shallow depth, and underlain by impervious, stratified, and cemented or partly consolidated deposits of gray to reddish-brown rounded gravel derived from basaltic and andesitic rocks. Finer interstitial material derived from volcanic tuffs and breccias of the Tuscan formation is also found in places in the underlying material. Large quantities of subangular to rounded bowlders of volcanic rocks occur throughout the soil section and scattered over the surface. The slope is generally sufficient to carry off surface drainage waters, but underdrainage is deficient owing to the impervious character of the subsoil material. The series occupies barren, treeless valley plains, of sloping to rolling topography, sometimes traversed by intermittent or permanent stream courses. So far as mapped, the soils are of very little agricultural value.

Area and distribution of the soils of the Tuscan series.

Soil name.	State or area.[1]	Acres.
Tuscan stony sandy loam	California 16	25,728
stony loam	do	8,000
Total		33,728

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

Sands derived from the Coastal Plain and older alluvial valley-filling material have as yet been encountered only under two series occupying the arid plains of the southern half of the interior valley of California.

The soil is of loose, porous character, deficient in power to retain moisture, and is best suited to intensively cultivated fruits or truck crops. Grains or other shallow-rooted crops can not be grown without irrigation. In the areas in which it has been mapped it is underlain by impervious hardpan substrata which to a great degree prevent loss of water by percolation under irrigation, but excessive irrigation may result in poor drainage and unsuitable subsoil conditions, and the relatively impenetrable character of the substrata prevents the development of trees, vines, or of the roots of other deep-rooted farm crops, except when broken up by blasting. Where the hardpan closely approaches the surface and has not been shattered by blasting, the soil is unsuitable for trees or other deep-rooted crops.

Under favorable conditions of depth, subsoil, irrigation, cultivation, and climate it is excellently adapted to the production of early berries, melons, truck crops, or stone fruits. Figs, early peaches, apricots, nectarines, and cherries are the leading products. Plums, olives, prunes, and oranges are grown to some extent. Raisin grapes constitute an important product, but are better suited to the other soils of the regions in which the sand occurs. Alfalfa is successfully grown, but only to a limited extent. It thrives better upon the deeper soils of heavier texture.

Grains are extensively grown in areas incapable of irrigation, the yields being light.

Madera sand.—The soil consists of a loose, friable, reddish-brown sand of medium texture, extending to a depth of 3 to 6 feet. It is easily tilled and, unlike most of the other members of this series, does not puddle or become sticky when wet. It is underlain by 2 feet or more of slightly darker colored, porous, and coarse-textured sand. This gives way to the reddish hardpan characteristic of this series. The hardpan is slightly less dense than that found beneath the San Joaquin soils, is lighter in color, and sometimes calcareous. The type is partly of aeolian origin and represents material blown from dry stream courses and deposited on their windward side. The type occurs as long, narrow bodies in the vicinity of and parallel to shallow water courses. The surface is undulating and somewhat higher than surrounding types. Slight "hog wallow" mounds are sometimes found. It is somewhat deficient in moisture-retaining properties, and is usually devoted to dry-farmed grains.

The more level phases in which the hardpan does not closely approach the surface are, under irrigation, well adapted to the production of olives, grapes, figs, alfalfa, and stone fruits.

San Joaquin sand.—The soil consists of a reddish-brown or dark-brown sand of coarse to medium texture, slightly sticky, and of rather compact structure, but loose and friable under cultivation. It is underlain at 18 inches to 6 feet or more by a red, compact, sticky sandy loam or sandy adobe, grading into a red sandy or clayey iron hardpan. The type generally occurs upon treeless ridges and the summits of lower foothills or higher undulations of the valley plain. The soil is usually well drained and free from alkali, and in certain sections is well adapted to grapes and citrus and deciduous fruits.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
San Joaquin sand	California 3, 18	45,696
Madera sand	California 11	8,640
Total		54,336

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

Coarse sand has been encountered in this province in but one area, where it is restricted to a single soil series. It is of loose, porous texture, well drained, and of low moisture-retaining power. Under conditions favorable to frequent irrigation and under intensive cultivation the soil is adapted to early stone fruits, where not underlain by hardpan at shallow depths, and to early truck crops. By the aid of copious irrigation alfalfa may be grown, but the soil can not be said to be well adapted to this or to other farm crops. Owing to lack of irrigation facilities the soil is generally devoted to dry-farmed grain, with but light or unprofitable yields except in the most favorable seasons.

Madera coarse sand.—The type consists of 4 to 6 feet or more of a light-brown or reddish-brown very coarse sand, carrying some fine, water-worn gravel, coarse angular sandy and some micaceous material and underlain by the usual reddish ferruginous hardpan of this series at any depth below 4 feet. The hardpan is separated from the soil in places by a thin stratum of clay loam. The type occurs as narrow bodies along intermittent stream courses, as slightly elevated knolls and ridges between such waterways, or as small, irregular bodies intermingled with the other types of the Madera and the San Joaquin series. It is deficient in moisture-retaining properties and upon the higher, excessively drained bodies, yields of dry-farmed grains, to which it is usually devoted, are generally low. The more level and deeper phases of the type are, under irrigation, adapted to the production of alfalfa and small fruits.

Area and distribution of the coarse sand.

Soil name.	State or area.[1]	Acres.
Madera coarse sand	California 11	7,168

[1] For key to number in this column see p. 733.

FINE SAND GROUP.

The fine sands of the province are of limited occurrence and not of great agricultural importance. They have been encountered in but one locality and under a single soil series. Where mapped the soil has not been developed to agriculture to any extent, is forested, and when cleared is subject to drifting. It is not very productive and is best adapted to forestry unless heavily fertilized and protected by windbreaks.

Empire fine sand.—This soil consists of a light-gray to reddish-brown fine sand, extending to a depth of many feet. The surface 6 to 10 inches are slightly darker in color, owing to the accumulation of organic matter, which also gives the soil the appearance of having a heavier texture. When wet it is moderately compact, but when dry it is inclined to drift in exposed places. Small iron pellets are numerous throughout the soil section. The type occurs in the vicinity of coastal beaches or tidal estuaries. It has an undulating to uneven surface, often marked by ridges or hillocks from 15 to 30 or more feet in height. The general character of the surface is similar to that of sand-dune districts, although the type supports a growth of cedar, fir, spruce, and brush. Owing to the rough and uneven character of the surface and to the liability of the soil to drift when cleared, it is better left in forest than cultivated.

Area and distribution of the fine sand.

Soil name.	State or area.[1]	Acres.
Empire fine sand	Oregon 3	5,248

[1] For key to number in this column see p. 733.

SANDY LOAM GROUP.

The sandy loams included under the head of "Coastal Plain and Old Valley Filling Material" are widely distributed and have been recognized in four soil series.

One of these occurs in the humid, forested, coastal districts of southern Oregon, and is deficiently drained, of limited agricultural development, and, under present conditions, is best adapted to grazing. The other members occur extensively in the semiarid and arid interior valleys and the coastal valleys of California. In all cases the soils of the group are underlain by heavy, compact subsoils or by iron hardpan, which restrict the adaptation of the soil to crops. Surface drainage is well established, but underdrainage is often inadequate. Not much of the land has been placed under irrigation. Owing to the impervious character of the subsoils and underlying hardpan the types when irrigated require careful management.

Where not underlain by hardpan at shallow depths the soils, owing to the heavy, compact subsoil, have a large capacity for water and are retentive of moisture under cultivation. Restricted underdrainage, however, frequently renders them cold, late, wet, inclined to puddle, and not as well adapted to early crops as would be the case if the subsoils were more normal. Where shallow and underlain by hardpan they are not well adapted to alfalfa, or to vines, fruit trees, or other deep-rooted crops, unless improved by blasting, which is sometimes resorted to with excellent results. Otherwise they are utilized mainly for the production of dry-farmed grains. Under favorable climatic and cultural conditions they are adapted to berries and the shallower rooted small fruits.

The Pleasanton sandy loam has a retentive subsoil, where true hardpan is absent. The soil is adapted to grains and, with intensive cultivation, to late fruits. It is utilized mainly for the production of wheat and barley and of wine grapes; the dry-wine grape being successfully grown in the coastal intermountain valleys. The sand loams of the other series occurring within the province are most widely devoted to dry-farmed grains, but where well drained and of sufficient depth are utilized for the culture of figs, olives, small fruits, table, wine and raisin grapes, citrus fruits, cherries, peaches, plums, and alfalfa.

Blacklock sandy loam.—The soil consists of a dark, ashen-gray to black sandy loam, loose and incoherent, and of fine to medium texture, 6 to 12 inches deep. The organic-matter content is low. It is underlain by a dark-brown to black subsoil, extending to a depth of 3 feet or more, and separated from the overlying soil by a ferruginous sandy hardpan, from 2 to 4 inches in thickness, usually impenetrable to plant roots. The type occurs as flat to slightly rolling Coastal Plain deposits, in which sinks or small depressions of deficient drainage occur. The native vegetation consists of a stunted growth of fir, cedar, madroña, and other trees and shrubs. The type is practically uncleared and is utilized only for pasture. It is considered an unproductive and undesirable soil type.

Madera sandy loam.—The soil consists of a light-brown to dark reddish brown sandy loam, from 1 to 6 feet deep, rather sticky when wet, inclined to puddle under cultivation, and becoming hard and compact upon exposure to hot, dry weather. It is underlain by a reddish or reddish-brown subsoil and by a hardpan, which sometimes occurs within 1 foot of the surface and occasionally outcrops. The type often occurs as extensive bodies covering valley plains or as small, elevated or depressed areas among the soils of the San Joaquin series. The surface is level to slightly rolling, frequently dissected by intermittent stream channels, and marked by hog-wallow mounds and by occasional hardpan outcrops. It is mainly devoted to dry farming to grains. The more level and deeper phases, where irrigated, are adapted to vine fruits, figs, berries, and alfalfa.

Pleasanton sandy loam.—The soil consists of a red to reddish-brown, fine to medium sandy loam, heavy and sticky and inclined to puddle when wet. It carries fine to coarse angular gravel in varying amounts, and when dry is of light reddish brown color. The subsoil consists of 8 to 14 inches of a red to yellowish-red sticky clay or heavy clay loam of adobe structure, found at depths ranging from 18 to 36 inches. It is underlain at 3 to 4 feet by a yellowish-red loam, containing pockets of reddish or yellowish clay. It occupies nearly level to rolling and sometimes hilly areas. Drainage, as a rule, is well established, although the heavy subsoil tends to check the percolation of moisture. The type is free from alkali and practically treeless, except for a stunted growth of field oak. It is dry farmed to grapes, hay, or grain, or used for pastures.

San Joaquin sandy loam.—The soil consists of a light-red to dark-red compact, medium-textured sandy loam, rather sticky when wet, and underlain at a depth of 30 inches or more by a red, ferruginous hardpan, which, in places, outcrops. The hardpan is frequently separated from the overlying soil by a thin stratum of adobelike structure. The type covers extensive areas of high, treeless valley plains. It is free from alkali. The deeper soils of higher lying valleys are generally well drained, and adapted to grapes and other fruits and grain. Drainage over the lower lying areas is usually deficient.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
San Joaquin sandy loam	California 3, 11, 12, 13, 15, 18, 23.	642, 163
Madera sandy loam	California 11	74, 368
Blacklock sandy loam	Oregon 3	4, 864
Pleasanton sandy loam	California 8	3, 008
Total		724, 403

[1] For key to numbers in this column see p. 733.

STONY SANDY LOAM PHASE.

In this province the stony sandy loam phase has been recognized in but one area and as a member of a single soil series. It is underlain by a compact, gravelly subsoil and substratum ordinarily impervious to water and impenetrable to plant roots. The stone content is sufficient to interfere with cultivation. The type is of extensive occurrence and is used mainly for grazing during the winter and spring months, when it affords a fair growth of native grasses.

Tuscan stony sandy loam.—The soil consists of a reddish to reddish-brown, compact and rather sandy loam from 3 to 12 inches deep, carrying a surface accumulation of roughly rounded andesitic bowlders. The subsoil consists of water-worn gravel embedded in finer material derived from gray tuffs. The soil is subject to erosion and deep exposures of the underlying material occur in the ravines and canyons. The type is of extensive occurrences. It is usually treeless, and owing to its stony character and shallow depth is of but little value save for grazing.

Area and distribution of the stony sandy loam.

Soil name.	State or area.[1]	Acres.
Tuscan stony sandy loam	California 16	25, 728

[1] For key to number in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loams of this province have been recognized in three soil series occurring in semiarid regions of California. One of these is confined to the intermountain coastal valleys, the other two having a somewhat wider distribution in the Great Interior Valley where summer temperatures are higher and conditions more arid.

The gravel content renders the soil somewhat more porous, more leachy under irrigation, and less retentive of moisture than the sandy loams. The loss of water by gravity is, however, counteracted by the heavy subsoils or impervious hardpan, and in crop adaptation the soil does not differ greatly from the sandy loams of the same series. It is, however, more frequently of rolling or rough topography and not so well situated for irrigation.

In the Livermore Valley, where a gravelly sandy loam of the Pleasanton series has been mapped, the soil is generally less retentive of moisture and inferior in agricultural value to the sandy loam member of the series. It is utilized for grazing, although dry-wine grapes are grown upon the lower slopes.

In the Redding series the type is not well adapted to general farming without irrigation. The deeper areas are profitably utilized for peaches and small fruits under irrigation or intensive agriculture. The gravelly sandy loam member of the San Joaquin series is utilized mainly for the production of grains without irrigation.

Pleasanton gravelly sandy loam.—The soil is a brown or light reddish brown sandy loam, from 18 to 30 inches deep, and carrying a large proportion of gravel derived from a variety of rocks. The gravel content is sometimes excessive, and the surface is strewn with rounded to angular cobblestones. On the lower slopes the soil often shows a red tint. The surface is soft and spongy when wet, baking upon exposure. The subsoil is a red or yellowish-red gravelly clay loam ranging in depth from 6 inches to 2 feet, underlain by a gravelly loam containing a large quantity of coarse gravel and cobbles. The subsoil layer is sometimes absent. The topography is rough to hilly and broken and deeply dissected by frequent intermittent streams.

The drainage is excessive and the type deficient in moisture-retaining properties. The native timber growth consists of oaks and buckeye, occurring along ravines. Little of the type is under cultivation, and it is utilized mainly for grazing. Grapes are grown successfully on some of the lower slopes. The type is of low agricultural value.

Redding gravelly sandy loam.—The soil is a light-red to red, sticky sandy loam, carrying a moderate to large quantity of gravel, originally water worn but in some cases reduced to subangular forms through weathering. The gravel content is usually concentrated in the vicinity of minor surface depressions or along eroded slopes. At a depth varying from 12 to 24 inches the soil is underlain by a compact and tenacious red clay loam or heavy loam generally free from gravel, which has a tendency to check into cubical blocks upon exposure. The subsoil is of high water-holding capacity and seldom extends to a depth of more than 4 feet. It is underlain by an impervious ferruginous hardpan of cemented sand and clay, impenetrable to plant roots and usually from 1 to 6 inches in thickness. This rests upon masses of partially consolidated or indurated gravel, cobbles, sand, silt, and clay. This material is usually roughly stratified and is only partially permeable to plant roots. The soil material is derived from the weathering in place of old alluvial filling material of Quaternary age. The surface is gently to sharply rolling or hilly, the type occupying elevated or hilly dissected terraces and valley plains. It usually supports a growth of oaks and brush. Dry-farmed crops are grown with but indifferent success. Under irrigation, except in the more shallow phases, the type is well adapted to the production of berries, peaches, and other fruits.

San Joaquin gravelly sandy loam.—The soil consists of a light-red to deep-red sticky sandy loam, carrying considerable quantities of water-worn gravel, ranging in size from fine gravel to cobbles and extending to a depth of from 2 to 6 or more feet. It is underlain by red hardpan, sometimes encountered within 2 feet of the surface, the average depth being ordinarily somewhat greater than in the other members of the San Joaquin series. The type occurs as somewhat pronounced ridges or elevations occupying valley plains of sloping surface, but usually free from minor irregularities. It is devoted to dry farming to grains, but under irrigation it should prove fairly well adapted to the production of figs, olives, and possibly the citrus fruits.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Pleasanton gravelly sandy loam	California 8	8,960
Redding gravelly sandy loam	California 16	5,504
San Joaquin gravelly sandy loam	California 11	1,152
Total		15,616

[1] For key to numbers in this column see p. 733.

SANDY LOAM ADOBE PHASE.

Sandy loam adobe has been encountered in this province in but one area occurring upon the arid plains of the interior valley of California.

The adobe structure of the soil makes it compact and sticky and readily puddled when wet. Upon subsequent exposure during the dry season it bakes and becomes very refractory. When plowed under proper moisture conditions it can be maintained in a mellow, friable condition, and it is then retentive of moisture.

Where recognized, the phase is generally devoted to dry-farmed grains. Under favorable drainage and cultural conditions it is better adapted to general farm crops and late fruits than is the sandy loam of the same series and not so well suited to early maturing products. It loses moisture rapidly, however, when puddled and baked, and requires a more careful and thorough system of tillage and heavier farm equipment for efficient utilization.

San Joaquin sandy loam adobe.—The soil is similar in color, texture, depth, and other general features to the San Joaquin fine sandy loam. It has a dense, compact adobe structure, puddles readily, and checks upon exposure. It becomes heavier below the first foot, and is underlain by a red hardpan. It is principally devoted to grain crops under a system of dry farming.

Area and distribution of the sandy loam adobe.

Soil name.	State or area.[1]	Acres.
San Joaquin sandy loam adobe	California 3	12,691

[1] For key to number in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams derived from the Coastal Plain and old valley filling material have been encountered over small areas in the humid coastal regions of southern Oregon and more extensively in the semiarid and arid plains of the interior valley in California.

In Oregon this group is represented only by a member of the Empire series. It is loose, leachy, and porous, and inclined to be droughty during periods of dry weather, but holds moisture better than the lighter members of the same series. Where intensively cultivated it is adapted to berries, early vegetables, and bush fruits.

In California the fine sandy loams are underlain by compact and relatively impervious subsoils and frequently by a dense ferruginous hardpan impenetrable to plant roots. Their adaptation depends largely upon the depth of soil and character of the underlying material. Underdrainage is usually inadequate and the soils inclined to be cold, wet, and late. Like other soils of heavy texture, they tend to puddle and bake unless carefully handled.

Under favorable conditions of drainage and cultivation the fine sandy loams are easily maintained in a friable condition, and are adapted to general farming of a rather heavy type. Owing to the impervious character of the substratum, they are not suitable for alfalfa or other deeper rooted crops or to vines or tree fruits, except in the deeper areas or where the hardpan is broken by blasting.

The soil is extensively devoted to dry-farmed grains. Local areas are used for the production of alfalfa, small fruits, grapes, and orchard fruits. Areas of San Joaquin fine sandy loam of good depth in the Sacramento Valley are highly

developed under irrigation, where early Tokay table grapes, strawberries, and the later vegetables are grown successfully.

Corning fine sandy loam.—The soil is of yellowish-brown to red color, rather sticky when wet, and easily puddled, baking upon exposure. The subsoil is a red, compact, heavy loam or clay loam, the deeper portion being impervious and resembling hardpan. The type is derived from early sedimentary deposits and occurs as undulating or sloping, treeless valley plains, often marked by "hog wallows." Underdrainage is poorly established and the type is not adapted to deep-rooted crops, except where the hardpan has been broken up by blasting. It is generally devoted to dry-farmed grains, but under irrigation the deeper areas, or those improved by the use of dynamite, would be suitable for the production of grapes and tree fruits.

Empire fine sandy loam.—The soil is a brown or reddish-brown fine sandy loam, carrying considerable medium to coarse sand, and from 15 to 18 inches deep. A surface deposit of alluvial loam, derived from higher lying adjacent soils is often encountered. It carries considerable organic matter, producing field characteristics of a heavier soil, and is marked by the presence of small iron nodules and in places by a thin ferruginous hardpan. The subsoil consists of a loose fine sandy loam, usually characterized by alternating strata of brown and gray color to the depth of 36 inches or more. The soil material represents older marine Coastal Plain deposits subsequently elevated as terraces. The type occurs as Coastal Plain deposits of flat or undulating surface, in places marked by low, wind-blown ridges and shallow stream courses. It is covered by a native growth of brush and forest trees, consisting of fir, cedar, spruce, alder, and madrona. Where not too porous it is well adapted to intensively cultivated crops, such as berries, vegetables, and bush fruits.

Madera fine sandy loam.—The type consists of a light reddish brown fine sandy loam from 4 to 6 feet deep, underlain by hardpan. It occurs as small, comparatively level areas bordering intermittent stream channels, and is generally devoted to dry-farmed grains. It is subject to occasional overflow from adjacent streams, and owing to this feature is not well adapted to tree fruits. Under irrigation alfalfa, grapes, and small fruits could doubtless be successfully produced over a large proportion of this type.

San Joaquin fine sandy loam.—The soil is a smooth, compact, and somewhat silty red sandy loam, becoming rather sticky when wet. It is underlain at an average depth of 36 inches by a heavy red loam or clay grading with depth into a red ferruginous clay or sandy clay hardpan. Drainage is not ordinarily well established. The soil is generally devoted to dry farming to grains, but in favorable locations where the hardpan does not too closely approach the surface it produces valuable crops of table and wine grapes and of bramble and other small fruits.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
San Joaquin fine sandy loam	California 11, 18	35,200
Empire fine sandy loam	Oregon 3	19,200
Corning fine sandy loam	California 2	1,920
Madera fine sandy loam	California 11	1,152
Total		57,472

[1] For key to numbers in this column see p. 733.

LOAM GROUP.

The most northern occurrence of the loam group recognized in this province is found in the Blacklock series of southwestern Oregon. The type occurs near the coast and under humid conditions. It is of limited extent, poorly drained, and supports a forest growth. Clearing and preparing the land is more expensive than on some of the better surrounding soils, and for this reason the type is not highly esteemed for agriculture.

In the interior valley of California the loam soils of this province are of widespread and extensive occurrence. In the Livermore Valley, an intermountain valley in the coast ranges in California, the loam member of the

Pleasanton series is an important soil type. In the interior valley it occurs under the Corning, Redding, and the San Joaquin series.

Where underlain by heavy subsoils of high water-holding capacity but without a hardpan substratum, the type is generally well drained. It puddles readily when wet, has somewhat restricted underdrainage, and is not adapted to as early crops as would be the case under conditions of a more porous subsoil of lighter texture. Where characterized by the more impervious and impenetrable hardpan substratum, the defective subdrainage and refractory structure tend to seriously limit its adaptability to crops.

With thorough methods of preparation for planting and under intensive cultivation, the type is retentive of moisture and adapted to the general farm crops over the well-drained, deeper areas. Much of the type, however, because of shallow depth or lack of irrigation facilities, is suited only to the production of grains or other shallow rooted crops. Where irrigated the yield of grains is often light, but is profitable in seasons of favorable rainfall. The deeper soils, where capable of irrigation, are adapted to the production of late peaches, almonds, berries, or other small fruits and to table and wine grapes.

For its efficient utilization this soil requires a rather heavy farming equipment in implements and draft stock applicable to an intensive or an extensive system of agriculture, according to the character of crops grown, and demands careful management in cultivation and irrigation.

Blacklock loam.—This type varies from a light loam with an appreciable amount of fine sand to a rather heavy loam. The soil is dark gray to brown or black in color, and is usually friable except in areas of deficient drainage, where it becomes close and compact. The subsoil consists of a brown to black clay loam or clay extending to a depth of 3 feet or more. In areas adjacent to lighter soil types it is sometimes marked by the occurrence of more or less sandy material or strata of sand alternating with clay. The type occurs as small, flat, or gently sloping areas, sometimes marked by low mounds or ridges, or narrow, basinlike depressions of deficient drainage. The soil material consists of sediments derived mainly from sandstone and shale rocks, transported by streams and deposited as alluvial coastal plain sediments during a previous period of submergence and subsequently more or less modified by recent alluvial material. The forest growth consists of fir, cedar, alder, and bushes. Only a small proportion of the type has been cleared or utilized, and it is considered generally inferior to adjacent types, owing to expense of clearing and preparation for cultivation.

Corning loam.—The soil consists of a slightly compact, sticky, reddish-brown to red loam from 16 to 30 inches deep, sometimes carrying small amounts of gravel. When properly handled it is friable and readily tilled. The subsoil consists of a heavy, impervious clay loam or clay, encountered at an average depth of 24 inches and resting upon compact, partially indurated, stratified beds of clay, sand, and gravel. The type occupies a slightly lower elevation than the soils of the Redding series and frequently grades by insensible degrees into adjacent soils. The topography is gently rolling to level, with occasional small washes or ravines.

The type is, in general, less hilly and rolling than the Corning gravelly loam. It is usually well drained, with the exception of local depressions, and is treeless, except for an occasional scattered growth of oak. It is poorly adapted to dry farming, but under favorable conditions of irrigation would probably be found suitable for the production of peaches, almonds, berries, figs, and grapes. It is less well adapted to alfalfa, prunes, and other crops requiring deep, friable soils.

Pleasanton loam.—The soil is a light reddish brown to red loam carrying large amounts of fine to very fine sand and varying amounts of medium to coarse gravel, mainly of quartz. In some places the color varies from a bright red to yellow. Some of the higher lying bodies are very gravelly and marked with surface cobbles. The soil is sticky and boggy when wet and a crust forms upon the surface upon drying, but under cultivation it is friable. The subsoil is a red or yellowish-red, sticky clay or heavy clay loam of adobe structure. Small amounts of gravel are encountered at depths ranging from 12 to 30 inches. The subsoil is in turn underlain by a compact, reddish-yellow gravelly clay loam, usually extending to 6 feet or more. On the higher elevations the surface soil is shallow, the clay loam subsoil in places being exposed. The type occurs mainly along lower hill slopes and has a rolling to hilly topography, often broken by ravines and stream courses. It is well drained, except after heavy rains, when it becomes boggy. It retains moisture well. Nearly all of the

type is under cultivation and devoted chiefly to hay, grain, and wine grapes. Yields of hay and grain are light. With irrigation the soil should prove suitable for alfalfa and fruits.

Redding loam.—The soil consists of 8 to 12 inches of light-red or reddish-gray loam carrying small, rounded pebbles. The subsoil is a heavy, compact, tenacious red clay loam, with little gravel, extending to a depth of 3 feet where a red or mottled clay-iron hardpan is encountered. The hardpan usually lies nearer the surface than in the Redding gravelly loam. The type occupies slightly rolling, treeless sections of the upland plain. Drainage is deficient, especially in many depressed spots. It is unirrigated and largely devoted to grazing.

San Joaquin loam.—The type consists of a red, plastic loam of fine, silty texture, compact structure, and inclined to puddle, varying in depth from a few inches to 3 feet or more. Below the first foot a heavy, adobe-like structure usually prevails, the material merging into the underlying indurated sandy clay hardpan. The type covers extensive areas of the lower valley plains and is generally treeless, except in the vicinity of stream channels and flood plains. Drainage is usually poor. The hardpan layer frequently approaches the surface too closely to allow profitable crop production. The soil is generally devoted to grazing and dry farming to grains.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
San Joaquin loam	California 12, 13, 23	93,504
Corning loam	California 2, 16	84,224
Redding loam	California 16, 17	25,728
Pleasanton loam	California 8	13,120
Blacklock loam	Oregon 3	4,480
Total		221,056

[1] For key to numbers in this column see p. 733.

STONY LOAM PHASE.

The stony character of the surface material renders the use of farm machinery upon the stony phase of the loam group less effective and more difficult and costly than upon the loam soil. It causes the soil to be of more porous character and better suited to fruit crops requiring good drainage and moderately early soils than to the general farm crops. In this province the phase is confined to a single soil series occurring in the northern Sacramento Valley in California. This type is characterized by an impervious gravel hardpan occurring at shallow depths. Owing to this feature, the soil is deficient in moisture-retaining properties, becoming boggy and sticky when wet, but baking and losing moisture rapidly upon exposure to hot, dry weather. It is barren and unproductive and does not differ greatly in its relation to agriculture from the other members of the series It is best adapted to grazing.

Tuscan stony loam.—The soil is reddish to reddish brown in color, from 18 to 30 inches deep, and carries fewer bowlders and rock fragments than the stony sandy loam member of the series. It is underlain by old sedimentary deposits of impervious strata consisting of rounded basaltic and andesitic gravels and finer volcanic material derived from tuffs and breccias. The surface is level to rolling and traversed by drainage depressions or by occasional streams. The type is treeless and of little agricultural value except for grazing.

Area and distribution of the stony loam.

Soil name.	State or area.[1]	Acres.
Tuscan stony loam	California 16	8,000

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam phase of the loam group usually occupies a somewhat more elevated position than the nongravelly members of the same series and is more frequently of eroded or rolling character. This, with the gravel content, tends to promote better drainage conditions, together with the earlier maturity of crops. The topographic position is, with regard to the occurrence of frosts, also usually more favorable than that of the nongravelly members of the series.

In this province, however, the gravelly loams, so far as recognized, are confined to three series of soils occurring in the semiarid or arid plains of the Interior Valley of California, all of which are characterized by heavy, compact subsoils, relatively impervious to water, and in two of the series by a distinct iron hardpan, usually impenetrable to the roots of plants. The adaptation of the soils to the deeper-rooted crops is determined by the character of the underlying material and the depth at which they occur. The variable character of these features consequently affect the uses of the types to a marked degree.

Where underlain at shallow depths by subsoil or substrata impervious to water, subdrainage is arrested, and the soils when wet become boggy, cold, and late. They bake upon exposure during the latter part of the season, losing moisture rapidly and making tillage difficult. Under such conditions the soils are adapted only to grazing or to the culture of grains or other shallow-rooted plants. They differ from the loams of the same series in adaptation to crops only so far as local conditions of topography and of gravel content may affect drainage, early planting, or the use of farm machinery.

Where underlain more deeply by impervious substrata, excessive loss of moisture by percolation may be checked to the advantage of the farmer. The soils under such conditions are retentive of moisture and, when properly tilled, adapted to the general farm crops doing well on the loam soils. They are somewhat better adapted than the latter to vine and other fruits, which require only moderately early soils with moist but well-drained subsoils.

Owing to the small extent to which irrigation facilities have been developed, the gravelly loams of the province are generally used for grazing and for dry farming. Where favored by local conditions of climate, drainage, topography, and depth of soil and subsoil material, almonds, grapes, olives, figs, peaches, and citrus fruits may be grown.

Corning gravelly loam.—The soil consists of a light-red or reddish-brown loam of medium texture, often carrying considerable coarse sand and varying amounts of small, angular or water-worn gravel similar to that occurring in the Redding loam. The soil is usually of compact structure, becomes tenacious when wet, and bakes upon subsequent exposure. Under favorable conditions, however, it is fairly friable. It is underlain at 12 to 20 inches by a compact, heavy, tenacious red clay or clay loam, usually free from gravel, which is in turn underlain at a depth of 24 to 48 inches by partially consolidated layers of water-worn gravel and clay or silty material of yellowish-brown color. These strata are more or less impermeable, and the general subsoil condition may be improved by blasting. The type occupies a somewhat more elevated position than the surrounding soils and is frequently marked by abrupt slopes and terraces or by bluffs occurring along the river valleys or minor stream courses. The regional drainage is usually favorable, although local depressions of deficient drainage occur. The underdrainage is deficient, owing to the impervious character of the underlying material. The type is at present utilized mainly for grazing and is not capable of great development except under irrigation. Where irrigated it can be used for the culture of peaches, almonds, grapes, olives, figs, and, in favorable locations, to a limited extent, for citrus fruits.

Redding gravelly loam.—The type consists of a red heavy silty loam, from 6 to 15 inches deep, underlain by red, heavy, adobelike material which at depths ranging from 18 inches to 5 feet grades into gravel. Varying quantities of subangular, rounded, or flattened cobbles and pebbles occur in the soil. The type occurs on the higher, ancient valley plains and the lower foothills. Surface drainage is well established, but underdrainage is arrested by the underlying hardpan. The type is devoted to grazing or dry farmed to grains with moderate yields.

San Joaquin gravelly loam.—The soil to a depth of 10 to 20 inches is a red loam, containing considerable fine gravel. It is underlain by a bright-red heavy loam or clay loam of adobelike structure, usually containing no gravel and extending to depths of 2 to 4 feet, where hardpan is encountered. The type occupies high, rolling plains and slopes of the lower foothills. Surface drain-

age is good, but underdrainage is arrested by the underlying hardpan. The type is devoted to grazing and dry-farmed grains, with moderate yields.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Redding gravelly loam	California 17	57,216
Corning gravelly loam	California 2, 16	32,128
San Joaquin gravelly loam	California 12	22,848
Total		112,192

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loam soils of this province have been recognized and mapped in a large number of widely distributed areas in Washington, Oregon, and California.

In western Washington and southwestern Oregon they are situated in humid regions and are usually forested. In the former State types in three series have been mapped. They are characterized by a compact, partially indurated substratum of gravel, usually occurring at a depth of 2 to 5 feet. Agriculture has been developed to but a limited extent. The purposes to which the soils are best suited is dependent largely upon topography, the possibilities of effective use of farm machinery in the culture of general farm crops, and likelihood of destructive erosion. Prevailing soil, topographic, climatic, and economic conditions favor the production of hay crops, including clover, timothy, and oats, and the practice of dairying and stock raising. Climatic conditions prevent the production of wheat of hard quality, but promote a luxuriant growth of native grasses. In better-drained areas, potatoes, apples, and bramble fruits should prove successful. The steeper slopes should be protected by cover crops owing to their tendency to erode in periods of heavy rainfall.

In the humid coastal districts of southwestern Oregon, soils of this group have been mapped in two series, one of which is characterized by a sandy and the other by a heavy subsoil. In crop adaptation they are related to the clay loams of this group occurring in Washington, the type underlain by sandy subsoils being somewhat less well adapted to general farming and tree fruits, but slightly better adapted, under favorable drainage conditions, to small fruits and vegetables.

In the Columbia River Valley at the base of the Cascade Range, another type of the group covers extensive areas of elevated terraces. The subsoil is compact, but the topography is rolling and the areas well drained. Much of the land is still covered with a heavy forest growth. The type is well suited to general farming and better adapted to earlier and more highly colored apples and other fruits than the coastal districts. Pears and, in the better drained areas, prunes and cherries are successfully grown.

In the interior valley of California the group is represented by two types, both of which are characterized by an underlying hardpan layer. This usually occurs at shallow depths and has the same ill effects as in the lighter members of the same series. The production of small grains under an extensive system of dry farming is in these districts the principal use of the type. The deep-rooted crops are confined to small areas of the deeper soils or to areas where the underlying hardpan has been broken by blasting. Areas which can be used for fruit growing are usually less well adapted to the purpose than the sandy loam members of the series.

The profitable utilization of the soils of the group calls for a farming equipment adapted to a heavy type of farming.

Arago clay loam.—The soil ranges from a heavy silty clay loam to a light, friable clay loam, about 15 inches deep, and prevailingly light brown in color. The soil is usually free from gravel, but contains some fine sand. The subsoil consists of a brown to light-brown silty clay loam or clay loam resting upon shale or sandstone or upon gravel beds, which frequently outcrop at the surface. The type occurs on valley slopes, as remnants of elevated terraces, and is heavily forested. The soil material has been derived from the sedimentary,

altered, and eruptive rocks of the Coast Range, shales and sandstones predominating, and represents marine and estuarine deposits. Little of the type is at present under cultivation. In the areas farmed bramble fruits, strawberries, potatoes, grains, and hay crops have proved successful. The type should prove a good soil for the production of apples.

Copalis clay loam.—The soil consists of a yellowish-brown to dark-brown heavy silt loam or silty clay loam, carrying much organic matter, and from 12 to 18 inches deep. It rests upon a light-brown, yellow, or mottled yellow and gray compact clay, almost invariably underlain at a depth of 2 to 5 feet by a compact mass of loosely cemented basalt, quartz, sandstone, and shale gravel. Small quantities of gravel are also found in the soil and subsoil. None of the type is under cultivation, though it should prove well adapted to hay, grain, and pasturage. Fruits might also be successfully grown in the better drained areas.

Empire clay loam.—The soil consists of a clay loam, generally of light brown color, free from gravel, and extending to an average depth of about 15 inches, although the depth is subject to some variation and the soil may extend to a depth of 3 or more feet. When in a favorable moisture condition the soil is friable and is readily maintained in a good condition of tilth. It is underlain by a reddish-gray to light-brown sandy subsoil, carrying small iron pellets. The topography is flat to undulating, the type consisting of more or less elevated marine terraces and plains, traversed by occasional broad, shallow valleys carved by stream action and rising with abrupt slopes to the terrace level. The soil material is derived from the rocks of the Coast Range Mountains deposited as marine sediments. It has been subsequently modified by the addition of fine material washed from adjacent slopes by rains or deposited from flood waters of minor foothill streams. The type supports a heavy forest growth and has been developed for farming purposes only to a small extent. It is adapted to the production of grains and hay crops, and in favorable locations apples, berries, and small fruits can be grown.

Hesson clay loam.—The soil to a depth of 10 to 12 inches consists of a dark reddish brown clay loam carrying rounded, water-worn quartzite pebbles, found most abundantly upon the surface and along the eroded banks of streams. The subsoil consists of a reddish-brown compact clay, becoming heavier and more compact in the lower part of the 3-foot section. The bedrock is of basalt, but seldom encountered within 6 feet of the surface. The topography varies from comparatively level to rolling. The soil represents the highest and oldest terraces in the Columbia River Valley. The natural timber growth consists of fir, hemlock, and some cedar. The soil is well adapted to general farming and to tree fruits, including prunes, pears, cherries, and apples.

Hoquiam clay loam.—The soil consists of a reddish-brown to red heavy silt loam or clay loam from 12 to 15 inches deep. It is underlain by a reddish-brown to red clay loam subsoil from 3 to 10 feet deep, which in turn rests upon a compact mass of loosely cemented sandstone, basalt, quartz, and shale gravels. Strata of impure sandstone are frequently found embedded in or overlying the gravels, and small amounts of gravel occur throughout the soil and subsoil. The more level areas of this type should be well adapted to all crops grown in the region, but especially to small grains, hay, and clover. Cover crops are necessary on the steeper slopes during rainy seasons as protection against erosion. Fruit growing should also prove a profitable industry in favorable localities.

Madera clay loam.—The type consists of a light grayish brown to reddish-brown sticky and compact clay loam, from 3 to 6 feet deep, resting upon hardpan. It is readily puddled if cultivated when wet, and is somewhat difficult to handle except under favorable moisture conditions. The type is of limited extent and found along the smaller stream courses. It is devoted principally to dry-farmed grains, but under irrigation the deeper phases could probably be successfully used for alfalfa.

Montesano clay loam.—The soil consists of a black silt loam or silty loam, from 16 to 24 inches deep, carrying a high percentage of organic matter. It is underlain by a compact clay loam or sandy clay loam, varying in color from gray with yellow mottlings to yellowish brown with gray mottlings. This material rests upon a compact mass of loosely cemented sand and gravel at a depth of 2½ to 5 feet. Small amounts of gravel are frequently found in both soil and subsoil. The subsoil is mellow, usually well drained, and easily cultivated. Only a part of the type is under cultivation, although it may be prepared for crops at

relatively little expense. The type is very productive, oats yielding from 45 to 75 bushels per acre, wheat from 25 to 40 bushels, and hay from 1½ to 2½ tons. Potatoes and fruits are also grown.

San Joaquin clay loam.—The type consists of a red or reddish-brown, sticky clay loam, from 2 to 4 feet deep, decidedly boggy and inclined to puddle when wet and becoming compact and hard upon subsequent exposure to hot, dry weather. It is underlain by a dense, impervious red hardpan. The surface is usually marked by "hog-wallow" mounds and depressions, but is otherwise of less irregular character than the San Joaquin sandy loam. It is generally dry farmed to grains, with somewhat lighter yields than are obtained from the San Joaquin loam.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Hoquiam clay loam	Washington 5	204,800
Hesson clay loam	Washington 7	37,888
San Joaquin clay loam	California 11, 15	24,512
Copalis clay loam	Washington 5	23,808
Empire clay loam	Oregon 3	18,112
Arago clay loam	do	8,320
Montesano clay loam	Washington 5	4,096
Madera clay loam	California 11	2,048
Total		323,584

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty phase of the clay loam group is represented by one soil type and found in only one locality in a humid region.

The type is at present in forest and not utilized for agriculture, though well adapted to small grains, berry crops, dairying, and stock raising. Vegetables of the heavier type could also probably be grown. It requires a slightly heavier equipment than the clay loam of the same series.

Montesano silty clay loam.—The soil consists of a black silty clay loam, 12 to 14 inches deep and high in organic matter. It rests upon a mottled gray, yellow, and black clay loam or clay which is underlain, at an average depth of 30 inches, by a compact mass of sand, gravel, and clay, though this material may lie much nearer the surface. Small amounts of gravel are found in both soil and subsoil. Under proper moisture conditions the type is easily cultivated. In some areas the soil contains so much organic matter that it has the appearance of Muck. Such areas are generally treeless and are locally termed "prairies." The greater part of the type supports a stunted and tangled growth of cedar, spruce, fir, and pine. None of it is under cultivation, but when cleared and drained it should be well adapted to the cultivation of hay, small grains, and some vegetables.

Area and distribution of the silty clay loam.

Soil name.	State or area.[1]	Acres.
Montesano silty clay loam	Washington 5	13,056

[1] For key to number in this column see p. 733.

GRAVELLY CLAY LOAM PHASE.

The only occurrence in this province of the gravelly phase of the clay loam as yet recognized appears in a single soil series occurring under semiarid climatic conditions in the coastal intermountain districts in California. The type here occupies areas of rough, broken topography, is not adapted to the use of farm machinery, is excessively drained, and devoted only to grazing. The clay-loam member of this series has not as yet been encountered.

Pleasanton gravelly clay loam.—The soil consists of a dark-brown clay loam with considerable amounts of angular fine to coarse gravel, the soil becoming lighter and more gravelly upon ridges. In places it is marked by small areas of adobe soil without gravel. Many small bowlders are present on the surface and distributed through the soil. The subsoil is a yellowish-red to dark reddish brown clay loam, becoming lighter in texture and more gravelly at depths of 4 to 5 feet. At 6 feet or more it is underlain by a reddish-yellow clay loam of adobe structure. The topography is rough and broken, with numerous ridges, separated by ravines from 300 to 400 feet deep. The surface is sometimes broken by landslides. Drainage is ordinarily excessive and the type nearly barren of trees. It is devoted mainly to grazing and is of low agricultural value.

Area and distribution of the gravelly clay loam.

Soil name.	State or area.[1]	Acres.
Pleasanton gravelly clay loam	California 8	832

[1] For key to number in this column see p. 733.

CLAY LOAM ADOBE PHASE.

The adobe phase of the clay loam group, so far as mapped, includes a single soil type found in the semiarid plains of the California interior valley. The normal clay loam member of this series has not as yet been recognized.

The adobe structure of the type is pronounced. Surface drainage is poorly developed and underdrainage checked by the underlying hardpan layer. These features render the type sticky and boggy when wet and make tillage difficult, except under favorable moisture conditions. The type is devoted mainly to pasture or to the production of grain hay, but when protected from overflow the deeper and better drained areas will probably be found suitable for the production of table grapes under intensive cultivation. The soil has a high capacity for the storing of moisture, and when maintained in a favorable condition of tilth its drought-resistant qualities are greatly increased.

As with the other adobe phases of the soils of the Pacific coast region, the adaptation of the soil to crops is to a large degree determined by its structure, which may vary widely according to drainage conditions. It is adapted to a heavy type of farming and to the successful culture of grains or other shallow-rooted farm crops or the deeper-rooted intensively cultivated special crops, which require a heavy farming equipment.

Alamo clay loam adobe.—This type is a dark reddish brown to dark-drab heavy clay loam with marked adobe characteristics, underlain at an average depth of 30 inches by a dense red iron hardpan. Because of its low position the type has been modified in places by standing water and alluvial wash. It is difficult to till, being practically a bog when wet and when dry cracking into large clods which are broken down with difficulty. Uncultivated land cracks badly on the surface when dry. The topography is generally level, with occasional shallow depressions. Drainage is poor, and much of the type is inundated during periods of stream overflow. It is mostly used for hay and pasturage. Where protected from overflow it is well adapted to the Tokay variety of grapes.

Area and distribution of the clay loam adobe.

Soil name.	State or area.[1]	Acres
Alamo clay loam adobe	California 12	18,368

[1] For key to number in this column see p. 733.

CLAY GROUP.

Clay types are generally wanting in the areas mapped in this province, the environment apparently being such as to favor development of the adobe phases of the soils of heavy texture. The normal clay group of the province is so far

represented by a single soil type, which occurs in the humid coastal districts of southwestern Oregon.

This type is usually poorly drained, carries a high content of organic matter, and when wet is plastic and refractory in character. Under favorable conditions of moisture supply and cultivation, however, it is easily maintained in a proper condition of tilth. It is adapted to dairying and to a heavy type of general farming. Artificial drainage and intelligent cultivation are necessary to its most successful utilization. It is generally of somewhat less refractory character and more amenable to cultivation under average conditions than the heavy adobe soils of the province.

Blacklock clay.—The type consists of a dark-gray to grayish-brown or black clay, carrying liberal amounts of organic matter in the surface soil but becoming dense and impervious in the lower portion of the soil section. The soil is friable under favorable conditions of moisture, but heavy and plastic when wet, making cultivation difficult. The average depth of the soil section is slightly over 3 feet. The type occurs as low-lying, poorly drained flats or depressions upon the Coastal Plain. It probably represents former marine lagoons or brackish-water lakes caused by the impounding of minor streams by drifting sands and the formation of lagoons by extension of sand spits and bars. The surface soil material is largely derived through deposition, under swamp conditions in the lagoons and depressions, of the finer sedimentary material washed from adjacent slopes by the flood waters of minor streams. The sandy materials of the subsoils represent the original sandy marine deposits of the Coastal Plain. Drainage is ordinarily deficient, and the type is usually covered with swamp vegetation, including willow and other trees. When cleared this type is used mainly for pasture or the production of oats, corn for fodder, vetch, clover, cowpeas, and sometimes alfalfa.

Area and distribution of the clay.

Soil name.	State or area.[1]	Acres.
Blacklock clay	Oregon 3	4,864

[1] For key to number in this column see p. 733.

CLAY ADOBE PHASE.

In the semiarid and arid districts of California the adobe structure is developed to a greater or less extent in most of the heavy-textured soils. True clays have not as yet been recognized in these districts, but the clay adobe phase is of quite frequent and widespread occurrence in both the interior valleys and in the coastal valley districts.

The Pleasanton clay adobe, mapped in the Livermore Valley, is of rough, dissected topography, not adapted to the use of farm machinery, and of comparatively little agricultural importance.

The clay adobes of the San Joaquin and Alamo series occurring in the interior valley are, like the other members of these series, characterized by an impervious hardpan layer and by the features of structure, surface, and subdrainage, relation to tillage, and to the growth of crops common to the clay adobe members of the same series. The heavy, compact, intractable structural condition is, however, somewhat more pronounced, and drainage conditions are not so well established.

The soil possesses a very high moisture-retaining capacity, however, when in favorable physical condition, and is adapted to shallow-rooted farm crops. Where not too shallow, table grapes could probably be grown if intensively cultivated. The soil requires careful management, thorough cultivation, and the heaviest equipment of implements and draft stock for its proper utilization.

Alamo clay adobe.—This soil consists of 1 to 5 feet of dark-gray to black clay loam adobe underlain by a red iron hardpan. The soil cracks badly on drying out, often to a depth of 2 feet or more. Natural drainage is very poor and a large proportion of the type is subject to overflow during the rainy season, either by water backing up over the lowlands, or due to breaks in the levees. The soil material consists of alluvial sediments transported by sheet wash or minor streams and deposited on low-lying, poorly drained, swampy plains subject to overflow. The type is used for grazing or sown to grains for hay. If

protected from overflows, grapes and certain of the shallow-rooted farm crops and fruits would do well.

Pleasanton clay adobe.—The soil is a dark-brown to reddish sticky clay, from 18 inches to 3 feet deep, containing considerable angular gravel, particularly on the ridges. It is often of adobe structure. The subsoil is a reddish-yellow sticky clay or clay loam, often giving place to yellowish silty clay loam, and underlain by a gravelly layer at a depth of 5 or 6 feet. Sometimes the soil rests upon a gray to yellowish-gray silt loam which is not underlain by gravel. The topography is rough and broken, with high, narrow ridges, steep slopes, and deep ravines. Drainage is excessive, but the soil is more retentive of moisture than the lighter types of this series. The natural vegetation consists of a scattering growth of live oak, field oak, and buckeye. Much of the type is too rough for cultivation and is devoted to pasture. A small acreage is used for hay, of which light yields are obtained. The value of the type is low.

San Joaquin clay adobe.—The soil consists of a dense, compact red clay adobe about 3 feet deep, which puddles readily when wet and checks upon exposure. It is underlain by the dense red hardpan. The soil possesses well-developed moisture-retaining properties. Drainage of the type is restricted. The soil is generally devoted to dry farming to grains.

Area and distribution of the clay adobes.

Soil name.	State or area.[1]	Acres.
Alamo clay adobe	California 12, 18	32,000
San Joaquin clay adobe	California 15, 18	5,760
Pleasanton clay adobe	California 8	5,568
Total		43,328

[1] For key to numbers in this column see p. 733.

ALLUVIAL FAN AND VALLEY FILLING MATERIAL.

The soils in this province are derived from a great variety of material, the character of which can usually be determined by a study of the physiographical features of the locality. Much of it is transported by intermittent streams, generally of high gradient, which after issuing from the mountains or foothills have had no permanent channel, but have shifted from side to side as their load of sediment has been deposited, until the surface shows a characteristic fan shape with its apex at the point where the stream emerges from the hills. This stream outwash material, being subjected to short intervals of water action, has different characteristics from the soils formed through other agencies.

The materials are derived from a variety of rocks, similar to those giving rise to the soils of the Coastal Plains and Old Valley Filling group. In addition some of the soils of the province have been derived mainly from glacial material. Some of the older of the valley-filling material included in this province is not greatly different from some of that included within the preceding province.

The soils derived from glacial material occur under humid conditions in the vicinity of the glaciated regions of the Northwest. The other types of this province occur in subhumid to arid regions. They are utilized for a wide variety of general farm and special crops. Drainage is sometimes poorly developed in some of the soils of heavier texture occupying comparatively flat valley plains. The alluvial fan material and the soils of the more sloping valley plains are generally well drained. They are, as a rule, admirably adapted to irrigation. They are used largely for small grains without irrigation, and where favored by local climatic and topographic conditions and by facilities for irrigation where necessary they are adapted to the production of general farm crops and citrus and other fruits.

DESCRIPTION OF THE SOIL SERIES.

Arbuckle series.—The Arbuckle series consists of light-brown or reddish-brown soils, underlain by reddish-brown to brown subsoils, and occurring as alluvial deposits covering sloping alluvial fans and plains often traversed by

intermittent streams. These are frequently quite deeply intrenched below the surface or inclosed by natural stream-built levees. The soils of this series are derived mainly from conglomerates and shales. They are similar in origin to the soils of the Willows series, but differ in the lighter brown or gray color, more elevated position, and the more friable structure of both the soils and subsoils. Some of the types support a scattered growth of oak or chaparral brush, which is not the case with the Willows soils. They are often deposited over soils of the Willows series or other soils of the valley plains, are generally well drained, productive, and under irrigation well adapted to the production of fruits.

Area and distribution of the soils of the Arbuckle series.

Soil name.	State or area.[1]	Acres.
Arbuckle gravelly sandy loam	California 25	24,000
fine sandy loam	do	3,200
loam	do	18,304
gravelly loam	do	16,128
silt loam	do	1,600
clay loam	do	21,632
Total		84,864

[1] For key to number in this column see p. 733.

Barron series.—The soils are gray to grayish brown and contain conspicuous particles of mica, quartz, and feldspar derived from granite rocks. The subsoils are heavy and compact, varying from brown to yellowish brown in color. The series occupies sloping to hilly and rolling areas lying at the foot of mountain ranges such as the Siskiyou Mountains in Oregon. The soil material is mainly of colluvial origin or has been laid down as alluvial fan deposits. The subsoil is residual and derived from underlying shales. The soils of the series are well drained, frequently traversed by small streams, and support a forest growth. Bowlders and rock outcrops are of occasional occurrence.

Area and distribution of the soils of the Barron series.

Soil name.	State or area.[1]	Acres.
Barron coarse sand	Oregon 4	6,528
sandy loam	do	1,792
Total		8,320

[1] For key to number in this column see p. 733.

Bellavista series.—The soil and subsoil material to a depth of 6 feet or more ranges from ashy gray to grayish brown in color, and is characterized by the occurrence of sharply abraded fine material and subangular to rounded fragments or pebbles of pumice and basaltic rock. The series occupies stream terraces or second bottoms. The soils are well drained and not subject to overflow. They are mainly of alluvial origin, the material consisting largely of pumice and volcanic ash, deposited by streams and subsequently modified by the mixture of colluvial or alluvial material from adjacent basaltic slopes and cliffs.

Area and distribution of the soils of the Bellavista series.

Soil name.	State or area.[1]	Acres.
Bellavista sandy loam	California 17	3,328
fine sandy loam	Oregon 4	576
Total		3,904

[1] For key to numbers in this column see p. 733.

Capay series.—The soils are fine-textured, plastic, and compact, ranging in color from dark gray or light to dark brown, and underlain by compact, light to reddish-brown or yellowish-brown loam subsoils. They occupy low depressions or shallow basins formed by intermittent lakes or ponds found in semiarid valley plains. The subsoils are light brown. The material is derived predominantly from the weathering of metamorphic rocks of the Coast Range Mountains modified by material washed from more elevated areas of the Yolo, Sites, and other soils during periods of freshets and heavy rains. Drainage is often deficient and the surface generally flat or of but slight slope. The soils are puddled readily, are often unproductive, and frequently carry accumulations of alkali salts. They are mainly used for the production of grain and grain hay.

Area and distribution of the soils of the Capay series.

Soil name.	State or area.[1]	Acres.
Capay clay loam	California 25	1,600
clay	do	34,560
clay adobe	do	31,232
Total		67,392

[1] For key to number in this column see p. 733.

Clawson series.—The soils and subsoils are of black color, the soil material being characterized by a noticeable content of granite particles. The series is poorly drained and occupies sloping to undulating mountain foot slopes and lower foothill areas in the vicinity of the Siskiyou series. Erosion is not active. The soil material is of colluvial origin derived from granite rocks. The subsoil material is partly residual, mainly from underlying shales, but includes some colluvial material similar to that forming the soil. The subsoil is underlain usually by shale and rarely by granitic rocks. The members of the series are usually of good slope, but subject to seepage from surrounding, more elevated water-bearing strata.

Area and distribution of the soil of the Clawson series.

Soil name.	State or area.[1]	Acres.
Clawson loam	Oregon 4	768

[1] For key to number in this column see p. 733.

Coker series.—The soils are brown to black, sometimes showing a slight grayish tint when dry. They are frequently shallow and underlain by light-brown to dark-brown or black subsoils of heavy texture, usually resting on basaltic bedrock. The series occurs upon gently sloping or undulating to comparatively level valley slopes. The lower lying areas are generally treeless and traversed by minor intermittent streams. They are not subject to overflow. Surface drainage is sometimes deficient and underdrainage often restricted. The higher lying areas found on the hill slopes often support a fair growth of forest. Drainage over such areas is good. Outcrops of basaltic rock are frequent. The soil and subsoil material is alluvial in origin, deposited by sheet flood and minor streams. The series, in favorable locations, is adapted to certain fruits.

Area and distribution of the soil of the Coker series.

Soil name.	State or area.[1]	Acres.
Coker clay adobe	Oregon 4	6,528

[1] For key to number in this column see p. 733.

Coleman series.—The soils of the Coleman series are of grayish-brown or light-brown to brown color and often of porous structure. The subsoils are generally of heavy, compact structure, and of light-brown or yellowish-brown color. They occupy sloping to comparatively flat or low, broad alluvial fans and narrow mountain valleys. Drainage is well developed, the soils being traversed by many mountain streams, often of an intermittent character. The soils are derived predominantly from material eroded from metamorphic rocks. The soils are usually well adapted to irrigation.

Area and distribution of the soil of the Coleman series.

Soil name.	State or area.[1]	Acres.
Coleman gravelly loam	Oregon 4	5,888

[1] For key to number in this column see p. 733.

Corralitos series.—The soils are of chocolate-brown or dark-brown color. The subsoils are of light-brown to brown color and usually occur at a depth of about 3 feet. Water-worn gravel and fragments of shale are found throughout the soil section. The members of the series are of alluvial origin, the material having been derived mainly from shales and distributed by sheet wash or by intermittent mountain streams. Under favorable conditions of climate they are adapted to apples, prunes, apricots, and vegetables.

Area and distribution of the soil of the Corralitos series.

Soil name.	State or area.[1]	Acres.
Corralitos loam	California 14	1,408

[1] For key to number in this column see p. 733.

Danville series.—The soils are dark brown to nearly black in color and carry more or less shale or angular rock fragments. The subsoils range from reddish brown to light brown, and are frequently mottled with gray and yellow. They are of pervious structure and carry considerable gravel. The series occupies smooth areas, with a gentle slope from the hills to the stream channels. The soils are well drained, although fairly retentive of moisture. The series consists mainly of colluvial material from the adjoining hills, derived predominantly from sandstone and shale rocks. The soils are used principally for fruit growing with some areas dry-farmed to hay and grain.

Area and distribution of the soil of the Danville series.

Soil name.	State or area.[1]	Acres.
Danville clay loam adobe	California 8	256

[1] For key to number in this column see p. 733.

Dublin series.—The soils are of very dark brown to black color, frequently carrying small amounts of angular shale gravel. The deeper subsoils are a light-brown to grayish or yellowish-brown color and of a heavy texture. The series occupies level to gently rolling alluvial slopes, fans, and alluvial valleys traversed by minor streams. There is nearly always a perceptible slope from the hills toward the stream channels. Drainage is in most cases well established, although some small flat areas would be improved by the use of tile. Alkali salts are occasionally noted over small areas. The soils are treeless or support occasional valley oaks, willow, or sycamore. They are used largely for production of hay and grain and small amounts of fruit.

Area and distribution of the soils of the Dublin series.

Soil name.	State or area.[1]	Acres.
Dublin loam	California 8	896
clay loam	do	1,344
clay loam adobe	do	1,152
clay adobe	do	14,848
Total		18,240

[1] For key to number in this column see p. 733.

Dungeness series.—The soils are light brown to gray in color and contain considerable fine sand and silt. They are frequently of compact structure and friable under cultivation. The subsoils are lighter in color than the soils, ranging from a yellowish gray to gray. They consist mainly of compact deposits of silt and fine sand and are frequently mottled with iron stains. These soils consist of sediments of silt, clay, and fine sand, derived mainly from glacial material laid down as terrace and alluvial fan deposits by the flood waters of streams before their channels had been cut down to the present level. The surface is gently sloping to undulating. The soils are not at present subject to overflow except those occupying a very limited area bordering the stream channels near their outlet. They occur under humid climatic conditions, and where uncleared are heavily forested with fir, cedar, spruce, and pine. They are adapted to hay crops, apples, small fruits, and truck.

Area and distribution of the soils of the Dungeness series.

Soil name.	State or area.[1]	Acres.
Dungeness fine sandy loam	Washington 5	8,960
silt loam	do	3,840
Total		12,800

[1] For key to number in this column see p. 733.

Dunnigan series.—The soils are gray to black and the subsoils light brown to brown, of heavy, compact structure. The type consists of alluvial outwash deposits of minor intermittent foothill streams or laid down by sheet wash. The material is derived from shales and sandstones. Surface drainage and underdrainage are poorly established. The soils occupy low, flat valley basins, often subject to overflow, and are usually adapted only to grazing unless protected from overflow and drained.

Area and distribution of the soil of the Dunnigan series.

Soil name.	State or area.[1]	Acres.
Dunnigan clay	California 25	8,576

[1] For key to number in this column see p. 733.

Esparto series.—The soils range from light brown to dark brown in color, are compact and friable, and from 2 to 3 feet deep. They are usually underlain by light-brown subsoils. They represent alluvial material derived principally from shales and deposited as flood plains and alluvial fan sediments during freshets by foothill streams, along the margins of semiarid valley plains, overlying the soils of the Capay and Yolo series. They are of recent origin or in process of formation. Drainage is usually well established and the soils are free from injurious amounts of alkali. The surface is gently sloping and the soils well suited to irrigation and retentive of moisture. They are adapted to grains, alfalfa, apricots, peaches, figs, almonds, and grapes.

Area and distribution of the soils of the Esparto series.

Soil name.	State or area.[1]	Acres.
Esparto loam	California 25	3,200
clay loam	do	8,832
clay	do	11,200
Total		23,232

[1] For key to number in this column see p. 733.

Exeter series.—The soils are dark brown to reddish brown, 6 feet or more in depth, friable, and often contain considerable fine gravel. They are somewhat sticky when wet and bake quite hard when dry. No hardpan occurs in the series. The surface is remarkably level and free from "hog wallows." The series consists of local alluvial deposits along stream courses. The soils are very productive and easily irrigated, both gravity and pumping systems being employed. They are adapted to citrus and deciduous fruits, grapes, berries, truck crops, and alfalfa.

Area and distribution of the soil of the Exeter series.

Soil name.	State or area.[1]	Acres.
Exeter sandy loam	California 15	2,240

[1] For key to number in this column see p. 733.

Fancher series.—The soils are friable and of red to reddish-brown color, the subsoil resembling the soil material in color, texture, and structure. The series is of alluvial origin and consists of outwash deposits of intermittent foothill streams, occupying gently sloping valley plains. The material is derived from erosion of the material of the San Joaquin series of soils. The members of the series are generally well drained and are particularly well adapted to the production of raisin grapes.

Area and distribution of the soil of the Fancher series.

Soil name.	State or area.[1]	Acres.
Fancher fine sandy loam	California 3	12,832

[1] For key to number in this column see p. 733.

Fresno series.—The soils vary in color from gray to light ash-brown, the heavier, low-lying members sometimes assuming a dark-gray color as a result of accumulations of organic matter. They are usually free from gravel and underlain, generally at depths of less than 6 feet, by light-gray to ashen-gray subsoils of fine texture and often of compact structure, the soil particles being of distinctly sharp character. A layer of white or bluish-gray, impervious, calcareous, alkali-carbonate hardpan, varying in thickness from a fraction of an inch to several inches, separates the soil and subsoil. The hardpan slowly softens under irrigation, but is normally impenetrable to the roots of growing plants. The soils of this series occur as old alluvial or colluvial deposits, derived principally from granite rocks, but carrying some material of volcanic sedimentary and metamorphic origin. They occupy sloping to undulating and generally treeless slopes of low, broad, alluvial fans. The lighter members are frequently windblown. The surface is sometimes rendered irregular by "hog wallows," wind-drifted ridges, or remnants of older stream channels. The members of this series are not often overflowed by streams, but are frequently poorly drained and suffer from seepage waters and alkali salts. Under favorable conditions of irrigation and drainage and where not underlain by hardpan too near the surface, they are well adapted to alfalfa, grapes, fruits, and

vegetables. They are extensively devoted to the production of dry-farmed grains in nonirrigated sections. They constitute leading deciduous fruit and raisin-grape producing soils in the irrigated sections in which they occur. The lighter members are the most important of the series and the hardpan, if present, lies at considerable depth and has no influence on the soil.

Area and distribution of the soils of the Fresno series.

Soil name.	State or area.[1]	Acres.
Fresno sand	California 3, 4, 11, 13, 23	314,614
coarse sand	California 11	1,280
loamy coarse sand	do	41,344
fine sand	California 13, 23	13,568
sandy loam	do	117,568
fine sandy loam	California 3, 4, 11, 13, 23	202,143
loam	California 1, 13	21,376
Total		711,893

[1] For key to numbers in this column see p. 733.

Hanford series.—The soils are generally of light grayish-brown or buff to light-brown color, the heavier members carrying considerable organic matter and becoming dark gray to nearly black when wet. They are micaceous, smooth to the touch, friable, and of porous structure, and generally free from gravel or bowlders. They range in depth to 6 feet or more. They are sometimes underlain by variable interstratified alluvial deposits at less than 6 feet. The soil material represents recent alluvial stream deposits, derived mainly from granitic rocks with a relatively unimportant admixture of other material. The soils occur usually as elongated bodies extending in the direction of stream channels and occupying flood plains, adjacent lower stream terraces, and alluvial valley plains. The surface is generally level to gently sloping, but is sometimes marked by slight ridges or undulations, or cut by sloughs or stream channels often bordered by willows and other trees. Such stream channels often appear as partially filled remnants of older stream courses or as intermittent streams which carry water only in times of flood and merge into the sandy washes. The lower-lying bodies or those occurring adjacent to stream courses are poorly drained or subject to overflow when not protected by levees. The soils of this series, while occasionally subject to the accumulation of alkali salts, are productive, and under favorable conditions of irrigation and drainage are well adapted to tree fruits, raisin, wine, and table grapes, nuts, vegetables, and truck crops.

Area and distribution of the soils of the Hanford series.

Soil name.	State or area.[1]	Acres.
Hanford sand	California 1, 9, 10, 15, 19, 20, 22	224,744
coarse sand	California 11	9,216
fine sand	California 1, 4, 9, 10, 11	119,234
sandy loam	California 4, 11, 15	94,548
coarse sandy loam	California 11; Oregon 4	3,584
fine sandy loam	California 1, 4, 9, 10, 11, 15, 19, 20, 22	208,[illegible]
loam	California 15	7,488
silt loam	California 9, 20, 22	58,[illegible]9
clay loam	California 1, 10, 11, 19	31,976
Total		758,321

[1] For key to numbers in this column see p. 733.

Kirkwood series.—The soils are dark gray, compact, and readily puddle. The subsoils are of grayish or grayish-brown color and of compact, impervious character. The soils are derived from reworked freshet and intermittent stream wash from adjacent soils of the Corning and related series, deposited over the local flat areas or low-lying depressions of semiarid valley plains and modified by conditions of deficient drainage. They are generally devoted to grazing or to dry farming to grains.

Area and distribution of the soil of the Kirkwood series.

Soil name.	State or area.[1]	Acres.
Kirkwood silty clay adobe	California 16	1,536

[1] For key to number in this column see p. 733.

Maricopa series.—The soils range from dark gray, through the darker shades of brown and chocolate, to black. They are loose, porous, ordinarily well drained, and free from alkali. The soils represent unassorted colluvial material formed by soil creep and direct washing from mountain sides and by the deposits of intermittent streams. The material is largely from granite rocks. Areas of these soils occupy mountain footslopes, delta fans, débris aprons, and sloping plains of filled valleys. They also occur in stream valleys as the product of a series of minor secondary fans or cones emerging from adjacent slopes or mesa lands. They are generally treeless and support only a desert vegetation, except where irrigated. The surface is frequently broken by arroyos, and the lighter members are gravelly and often strewn with bowlders. These soil bodies vary from small areas of irregular outline to broad, extensive uniform sheets. Where capable of irrigation they are generally well adapted to fruits, vines, and general farm crops.

Area and distribution of the soils of the Maricopa series.

Soil name.	State or area.[1]	Acres.
Maricopa sand	California 24	6,430
gravelly sand	California 10, 19, 20	194,886
sandy loam	California 9, 19	37,312
fine sandy loam	California 9	5,952
gravelly loam	California 10, 19, 20, 21, 24	47,160
loam adobe	California 9, 19	16,320
clay loam adobe	California 3, 4, 19, 21, 22	73,316
Total		381,376

[1] For key to numbers in this column see p. 733.

Medford series.—The soil and subsoils range in color from a light brown to dark brown and black, the coloring becoming darker in the heavier members. The coarser members usually contain conspicuous fine angular particles of granitic rock. The subsoils are usually of somewhat heavier texture than the soils. These types occur upon valley plains of gently sloping or nearly level to slightly undulating topography. They are often traversed by small intermittent streams, but are not subject to overflow. Drainage is ordinarily well established, although at times deficient. The series is of alluvial origin and represents material derived largely from erosion of the Tolo soils. In the lighter members the material has been subject to addition and admixture of material from granitic rocks, which forms the soils of the Siskiyou and of the Yarron series. The heavier members include less granitic material and more sandstone and shale material. The members of the series are found under a subhumid climate and in their virgin condition support a variable forest growth.

Area and distribution of the soils of the Medford series.

Soil name.	State or area.[1]	Acres.
Medford fine sandy loam	Oregon 4	3,456
gravelly fine sandy loam	do	320
loam	do	2,560
gravelly clay loam	do	6,400
clay adobe	do	768
Total		13,504

[1] For key to numbers in this column see p. 733.

Meyer series.—The soils are light brown to dark brown in color and carry in places water-worn basaltic gravel in small quantities. The subsoils are grayish brown to yellowish brown and frequently calcareous, the latter material occurring as soft marly beds, varying in thickness from an inch to a foot or more. The subsoils are underlain by bedrock and are often thin or wanting. The series occurs upon lower foothills and mountain slope areas of hilly to broken topography. Like the Phoenix series, the soils represent materials derived from gray sandstones and basaltic rocks, transported by colluvial and alluvial agencies. The members of the series are generally treeless. The underlying sandstone rock frequently outcrops in higher-lying areas, and the shales are occasionally exposed along eroded benches in the vicinity of the stream courses.

Area and distribution of the soils of the Meyer series.

Soil name.	State or area.[1]	Acres.
Meyer silty clay loam	Oregon 4	2,240
clay adobe	do	8,960
Total		11,200

[1] For key to numbers in this column see p. 733.

Modesto series.—The soils are of grayish to chocolate-brown color, and usually contain a noticeable amount of sharp quartz or granite sand with a large amount of finer material. The subsoil is heavy and compact and occurs at a depth of 12 inches. It ranges from gray to brown in color, and is also marked by the presence of coarse, sharp sand. This stratum is underlain by a light gray, silty, calcareous substratum, often cemented into a calcareous hardpan, and similar to the subsoil material of the Fresno series. The surface is often uneven and marked by hog-wallow undulations. Surface drainage varies from good to deficient. Underdrainage is generally restricted. The series is derived mainly from crystalline rocks, and has been laid down as alluvial fan or flood plain deposits of former streams. Under favorable conditions of irrigation and drainage the soils are adapted to alfalfa, grapes, peaches, vegetables, and berries.

Area and distribution of the soils of the Modesto series.

Soil name.	State or area.[1]	Acres.
Modesto loam	California 13	8,896
clay loam	California 11	13,824
Total		22,720

[1] For key to numbers in this column see p. 733.

Norman series.—The soils are dark brown to black, usually of compact structure, and vary in depth from 3 to 6 feet or more. The subsoils are of yellowish or bluish mottled color and of compact, rather impervious character. The series occurs in minor depressions of semiarid, treeless valley plains. The soils are poorly drained and subject to overflow, and often subject to accumulation of alkali salts. They represent alluvial deposits of shale and sandstone. They are generally devoted to grazing and dry-farmed grain, although much of the land is capable of irrigation.

Area and distribution of the soil of the Norman series.

Soil name.	State or area.[1]	Acres.
Norman clay adobe	California 2	6,208

[1] For key to number in this column see p. 733.

Oxnard series.—The soils are generally of dark color and compact structure, and, though sometimes underlain by porous subsoils of light texture, are generally underlain by heavier subsoils. The Oxnard subsoils, however, lack the red color and adobe structure of the subsoils of the Placentia series, occupying similar topographic positions. They represent alluvial delta plain deposits, from foothills and higher adjacent soil bodies, derived mainly from sandstones, shaly sandstones, and shales. The soils occupy sloping, elevated, and dissected mesa lands and plains and lower level valley and delta plains. They usually occupy a less elevated position than the soils of the Maricopa series, are generally derived from less elevated foothills and ranges, and are lacking in the granitic material of the former series. The soils of the Oxnard series where they occur in southern California are recognized as particularly adapted to the production of Lima beans, which industry has been here highly developed; also to sugar beets, barley, and vegetables, according to the texture. The lighter members are frequently wind blown and of gray to yellowish-gray color.

Area and distribution of the soils of the Oxnard series.

Soil name.	State or area.[1]	Acres.
Oxnard sand	California 9, 19, 24	56,520
sandy loam	California 19, 24	75,600
fine sandy loam	California 19	22,848
loam	California 19, 24	19,812
gravelly loam	California 10, 24	16,270
silt loam	California 24	5,320
clay loam	California 9, 21, 24	30,574
clay loam adobe	California 9, 19, 20, 24	76,580
Total		303,524

[1] For key to numbers in this column see p. 733.

Phoenix series.—The soils and subsoils of this series are of dark-brown to black color, of shallow depth, and marked by bowlders and occasional outcrops of parent rock. The heavier members are compact and often of pronounced adobe structure. The soils are mainly of colluvial and alluvial origin, and represent material transported by gravity and water and occurring as foot-slope sheet wash or alluvial material distributed by intermittent streams. The material has been derived mainly from gray sandstone, but includes a considerable amount of basaltic material. The subsoils are of residual origin and derived from underlying gray sandstone. The members of the series are not usually subject to destructive erosion. They are fairly well drained, although subdrainage is slow in the heavier types and surface drainage is deficient at times in lower lying areas.

Area and distribution of the soils of the Phoenix series.

Soil name.	State or area.[1]	Acres.
Phoenix clay loam adobe	Oregon 4	576
clay adobe	do	4,544
Total		5,120

[1] For key to numbers in this column see p. 733.

Placentia series.—The soils are reddish brown or brown and underlain by heavy, compact red loams or clay loams of tough, impervious adobe structure. The soil material consists of alluvial outwash deposits of intermittent or torrential mountain streams, subject to considerable modification by weathering subsequent to their formation. The lighter members are sometimes wind blown. They occur upon foot slopes, mesa lands, and broad, uniformly sloping alluvial fans and high, level to sloping valley plains. They are derived from granitic rocks. With the exception of the lighter members, they are generally well drained, free from alkali, and frequently of somewhat refractory nature. Subdrainage is often deficient. They are tilled with difficulty, but are retentive

of moisture and include large areas of valuable lands devoted to the production of grains, general farm crops, citrus and deciduous fruits, beans, and other special crops.

Area and distribution of the soils of the Placentia series.

Soil name.	State or area.[1]	Acres.
Placentia sandy loam	California 1, 19	66,688
sandy loam adobe	California 1, 22	36,454
fine sandy loam	California 9, 10, 19, 20, 21, 22	371,433
loam	California 22, 24	25,710
clay loam	California 19	2,816
clay loam adobe	California 9, 24	8,916
Total		512,017

For key to numbers in this column see p. 733.

Poplar series.—The soils are gray to buff-colored and somewhat micaceous. They are underlain at a depth of 2 to 4 feet by reddish-brown or light-brown subsoils of moderately heavy character and of compact structure. Red iron hardpan sometimes occurs in the deeper subsoils. The soil material is of alluvial origin, derived prevailingly from granitic rocks, and distributed by streams as a comparatively thin superficial deposit of low, broad alluvial fans over an earlier valley filling. In origin and process of formation it resembles the material of the Hanford series. The subsoil consists of somewhat weathered or alluvial material of the San Joaquin series. The members of the series occupy nearly level or gently sloping plains, and proper drainage is maintained with some difficulty under irrigation. They are devoted to grazing or under irrigation to alfalfa, small fruits, tree fruits, and truck crops.

Area and distribution of the soil of the Poplar series.

Soil name.	State or area.[1]	Acres.
Poplar fine sandy loam	California 15	5,632

[1] For key to number in this column see p. 733.

Portersville series.—This series includes reddish-brown to black soil with compact calcareous and often marly subsoils of the same color as the soil. The material is of metamorphic origin. The series occupies sloping, alluvial fans, colluvial slopes, and flat valley plains. Where irrigated, the land is used mainly for grain crops and pasturage. Under irrigation nearly all of the soils of this series are well adapted to citrus fruits. Deciduous fruits, grapes, olives, and berries also do well. No alkali occurs in this series, but in the heavier members of the group large quantities of lime are encountered in the subsoil.

Area and distribution of the soils of the Portersville series.

Soil name.	State or area.[1]	Acres.
Portersville clay loam adobe	California 15	32,832
clay adobe	California 11, 15	9,856
Total		42,688

[1] For key to numbers in this column see p. 733.

Redwood series.—The soils range from dark gray to black in color, and are often of compact structure and hard to handle. The subsoil is similar in general to the soil material in color, texture, and structure, but the deeper subsoil is often of drab color and striated with iron stains. Both soil and subsoil

contain large amounts of organic matter. The soils of this series represent old to moderately recent sediments derived from crystalline, metamorphic, and sedimentary rocks and deposited in estuaries or tidal marshes, lagoons, or bays by minor streams and sheet erosion. The topography is slightly sloping to level. Both surface and underdrainage are often deficient. Under favorable conditions of drainage and cultivation the members of the series are retentive of moisture and adapted to onions, cabbage, small fruits, apples, pears, prunes, grains, hay, and sugar beets.

Area and distribution of soil of the Redwood series.

Soil name.	State or area.[1]	Acres.
Redwood clay adobe	California 21	30,400

[1] For key to number in this column see p. 733.

Sequim series.—The soils vary from brown to rather dark brown, becoming nearly black in the surface few inches when moist, and containing a large quantity of gravel. They are underlain by brown to light-gray subsoils, containing gravel and cobbles, mixed with a large amount of fine interstitial material of light color, which becomes compact and impervious under irrigation and improves the moisture-retaining properties of the soil. The soils of this series occupy glacial outwash plains, usually along the Dungeness River at the base of the Olympic Mountains. The soil material consists of reworked sediments brought down from the hills and spread over the plain as an alluvial fan. The topography is level, with sufficient fall for irrigation and drainage purposes. Except for a few small clumps of fir and hemlock, these soils are treeless, but support a growth of native grasses. Although occurring under humid conditions, they are not well adapted to agriculture without irrigation, but where irrigated are productive and adapted to oats, clover, Canada field peas, alfalfa, small fruits, and fruits.

Area and distribution of the soil of the Sequim series.

Soil name.	State or area.[1]	Acres.
Sequim gravelly sandy loam	Washington 5	2,304

[1] For key to number in this column see p. 733.

Stockton series.—The lighter members of this series have a buff to reddish or chocolate-brown color; the heavier members generally exhibit a pronounced adobe structure, are usually free from gravel, and range from dark brown to dark gray or black in color. The soils are usually underlain by heavy loams or clay loams of lighter color, and are frequently separated from the overlying soil by a thin crust or zone of white calcareous clay hardpan free from alkali. The subsoils of the heavier members have probably been greatly modified by weathering and by the incorporation and decomposition of organic matter resulting from swamp or marsh conditions. This series occupies extensive areas of the lower, nearly level valley plains sometimes traversed by small foothill streams. The soils are treeless or are marked by occasional groves of valley oak. Drainage is usually restricted. The heavier members are difficult to handle, owing to their heavy texture and structure, and are devoted mainly to the production of grains and hay.

Area and distribution of the soils of the Stockton series.

Soil name.	State or area.[1]	Acres.
Stockton loam adobe	California 23	2,560
silt loam	do	16,512
clay loam	California 13	8,512
clay loam adobe	California 23	53,312
clay adobe	California 12, 13, 23	82,688
Total		163,584

[1] For key to numbers in this column see p. 733.

Sunol series.—These soils are of a brownish color, showing a slightly reddish hue when wet, and carrying angular rock and shale fragments. This material rests upon a brown to light-brown heavy subsoil, which becomes heavier with depth. The topography is level to gently sloping, and the drainage is thorough, though not excessive. No alkali is present. The soils consist largely of alluvial material. They are dry farmed to grain and hay.

Area and distribution of the soil of the Sunol series.

Soil name.	State or area.[1]	Acres.
Sunol loam	California 8	448

[1] For key to number in this column see p. 733.

Sutter series.—The soils are yellowish to dark brown or nearly black. They extend to a depth of 6 feet or more, or are underlain at less depth by subsoils of yellowish, brown, or black color or by bedrock. They consist of stream-outwash material derived from andesitic rock. The lower-lying areas, constituting alluvial plains, sometimes occur as flats or depressions subject to overflow by back water from adjacent large streams. Drainage as a rule is ample. While these soils are largely undeveloped and devoted chiefly to grazing or to the production of grains, certain types are well adapted to the production of alfalfa, almonds, and, in some cases, to melons and tree fruits.

Area and distribution of the soils of the Sutter series.

Soil name.	State or area.[1]	Acres.
Sutter sandy loam	California 12	11,264
loam	do	10,048
clay loam adobe	do	1,600
clay	do	1,024
Total		23,936

[1] For key to number in this column see p. 733.

Ulmar series.—These soils are light brown to dark brown in color, areas on the ridges often taking a reddish tinge when wet. The subsoils are of reddish-yellow or red color, and rest upon either a calcareous sandy hardpan or a very compact, impervious stratum, which in turn is underlain by a compact, yellow clay loam or clay. The series occurs upon alluvial valley plains, alluvial-fan slopes or foot slopes, and includes some colluvial material. The topography is generally level, with small ridges along old stream channels and a few "hog-wallow" areas. Drainage over much of the series is somewhat excessive. Some areas contain considerable alkali. The soils consist of material transported by minor intermittent streams and by sheet wash. This material is derived mainly from shale and sandstone, but has probably been modified more or less by swampy conditions. The soils are treeless, and are used for pasturage or dry-farmed grain and hay. Small areas are devoted to truck crops.

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Area and distribution of the soils of the Ulmar series.

Soil name.	State or area.[1]	Acres.
Ulmar fine sandy loam	California 8	832
loam	do	3,584
Total		4,416

[1] For key to number in this column see p. 733.

Willows series.—The soils range in color from brown to reddish brown or dark chocolate brown and are free from gravel. The subsoils are light brown to reddish brown, or sometimes yellowish, and mottled with gray. They are compact, relatively impervious structure, and often contain lime and gypsum. They are derived mainly from calcareous shales, sandstone, and shaly sandstone rocks, and occur along the stream courses and flood plains of small intermittent foothill streams traversing valley slopes and plains. The surface ranges from gently sloping to flat, and the heavier members are often poorly drained, subject to overflow, and contain alkali salts. In places the soil material of these types has been deposited in the waters of overflow basins or intermittent lakes. Where well drained and free from alkali they are well adapted to the production of alfalfa, grains, and, with the exception of those areas of extremely heavy texture, sugar beets.

Area and distribution of the soils of the Willows series.

Soil name.	State or area.[1]	Acres.
Willows loam	California 2, 25	6,720
silty clay loam	California 2	24,896
clay loam	California 2, 25	68,928
clay	do	46,976
clay adobe	do	141,184
Total		288,704

[1] For key to numbers in this column see p. 733.

Yolo series.—This series embraces alluvial soils of brown or dark-brown color underlain by lighter-brown subsoils. The types have been derived from schists and other metamorphic rocks, with some material from shaly sandstones and shales, the materials having been deposited as delta and flood-plain alluvium by the larger streams entering the interior valley of California. They are distinguished from the soils of the Willows series and of the Arbuckle series by their prevailing dark color, the more remote source of material from which they are derived, and by the frequent occurrence of groves or scattered specimens of valley oak. They are usually deep, free from injurious quantities of alkali, friable under cultivation, productive, and adapted to a wide range of crops. Where capable of irrigation fruits, vegetables, and forage crops can be grown.

Area and distribution of the soils of the Yolo series.

Soil name.	State or area.[1]	Acres.
Yolo gravelly sandy loam	California 2	11,840
fine sandy loam	California 2, 25	18,432
loam	California 2, 13, 23, 25	49,920
silt loam	California 25	13,504
clay loam	California 15, 25	31,296
clay	California 25	29,888
silty clay	do	11,072
Total		165,952

[1] For key to numbers in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

SAND GROUP.

The soils of the sand group derived from alluvial fan and recent valley filling material of the Pacific coast are, where mapped, confined mainly to the interior valley and to the southern coastal regions of California.

The group is best adapted to early truck and early stone fruits under irrigation. Of the vegetables grown watermelons constitute an important product in the interior valley, or in areas away from the cool, moist climate of the coastal region. Sweet potatoes are grown to some extent, and locally cucumbers, eggplant, muskmelons, lettuce, radishes, and other truck crops are produced for early market, though the most of these products yield somewhat more abundantly on slightly heavier soils. Early peaches and table or raisin grapes are quite extensively grown, particularly upon the sands of the Fresno and Hanford series; the grapes are also being used for the manufacture of heavy wines. Apricots and, in certain areas, cherries constitute another important crop, but are somewhat less profitable than where grown upon the fine sand, sandy loam, or fine sandy loam groups. Lima beans, peas, and English walnuts are successfully grown upon the types near the coast, but are less certain and profitable in the interior. The group is much too coarse in texture, porous in structure, and deficient in power to retain moisture to be adapted to farming without irrigation. Profitable, though not heavy, crops of alfalfa are obtained with copious irrigation. Citrus fruits, sugar beets, and early strawberries are grown to some extent upon the sand of the Oxnard series, but these crops do not constitute important products of the sand group. The production of citrus fruits is confined to the southern coast districts, while deciduous fruits are of importance mainly in the interior.

The sands occurring in this province have been, where favored by facilities for irrigation, highly developed, and contribute to the early fruit and vegetable products of the Pacific coast region.

Fresno sand.—The soil consists of a medium to coarse micaceous sand of light-gray or light-brown color and porous, loose incoherent structure, 6 feet or more in depth. It is generally underlain by a light-colored loam or sandy loam. The type is composed of old alluvial sediments, usually covering extensive areas. It occupies the higher, treeless valley plains, with a nearly level to slightly rolling surface. The soil is generally well drained, free from alkali, and ordinarily free from gravel. The type is adapted to alfalfa, truck, and stone fruits under irrigation.

Hanford sand.—The soil is a light-gray to brown, micaceous loose, porous sand of medium fine to coarse texture, generally 6 feet or more in depth, and underlain by stratified, alternating stream deposits. The type is composed of recent stream sediments occurring as irregular, elongated bodies, frequently slightly elevated or depressed, marking former stream channels, or as broad, extensive bodies covering lower stream terraces and delta plains. The surface soil is sometimes more or less drifted by winds. It is generally free from gravel, and is usually well drained, except where subject to overflow from adjacent streams. It is a fair fruit and truck soil if well irrigated, but is often leachy and deficient in organic matter.

Maricopa sand.—The soil consists of a light-gray sand of medium texture, 6 feet or more in depth, carrying considerable coarse, sharp, sandy particles, and sometimes marked in the lower part of the soil section by partially stratified layers of fine sands and loams. It is loose and porous and usually carries more or less rounded or partially rounded gravel, the fragments grading in size from pellets to cobbles. The type represents colluvial and partially assorted alluvial material distributed by intermittent streams and occurring as small, narrow bodies along the course of arroyos, or as broader areas covering mountain débris aprons or smaller secondary fans, or as fan-shaped plains bordering bluff lines and mesa lands. The surface is usually gently sloping, but is sometimes broken or hilly, slightly wind drifted, or traversed by intermittent stream channels or arroyos. The soil is adapted to fruits, vines, and general farm crops where favorably situated for irrigation.

Oxnard sand.—The soil is a yellowish-gray to brownish sand of porous, often incoherent, structure, and of medium to fine texture. It is generally 6 feet or more in depth and underlain by indurated sand, or in low, level delta plains by heavier material. The type occupies delta plains, mesa lands, and undulat-

ing hills. In exposed areas the soil is often wind blown, successful cultivation being possible only with the aid of windbreaks. The type is well adapted to lima beans and English walnuts. On areas containing a moderate quantity of alkali sugar beets are successfully grown, while in southern California grapes and citrus and deciduous fruits are produced.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Fresno sand	California 3, 4, 11, 13, 23	314,614
Hanford sand	California 1, 9, 10, 15, 19, 20, 22	224,744
Oxnard sand	California 9, 19, 24	56,520
Maricopa sand	California 24	6,430
Total		602,308

[1] For key to numbers in this column see p. 733.

GRAVELLY SAND PHASE.

The gravelly sands of this province are as yet represented by a single soil type, occurring in but few areas. It is of loose, porous structure and often deficient in organic matter, but in many places favorably situated for irrigation. It does not differ greatly in adaptation to crops from the normal members of the sand group and is best considered as an unimportant phase of the former.

Maricopa gravelly sand.—The type consists of a rather light to dark-gray sand of medium to fine texture, carrying an appreciable quantity of coarse, sharp particles and fine granitic gravel. It is generally 6 feet or more in depth. In its virgin condition the soil is somewhat compact, but under cultivation it becomes of a loose and permeable character and washes readily under irrigation. This soil frequently packs firmly in roads and forms a bed resembling macadam. The type is formed largely of unassorted colluvial granitic material, distributed by torrential and intermittent streams as broad, gently to abruptly sloping fans and débris aprons. Drainage is generally good and the soil free from alkali. When favorably situated for irrigation it is well adapted to vine, citrus, and deciduous fruits. Without irrigation grain crops can sometimes be grown.

Area and distribution of the gravelly sand.

Soil name.	State or area.[1]	Acres.
Maricopa gravelly sand	California 10, 19, 20	194,886

[1] For key to numbers in this column see p. 733.

COARSE SAND PHASE.

The coarse sand phase of the sand group, in so far as recognized by the Soil Survey, is of inextensive occurrence. Small areas occur in southern Oregon under a subhumid climate. The surface soil is of coarse, open, porous texture and droughty. The subsoil of these Oregon areas is compact and retentive of moisture.

Other inextensive areas of the coarse sand phase of the sand group occur in the more arid San Joaquin Valley in California, where types of this texture have been mapped in the Fresno and Hanford series. The phase is here, owing to the coarse texture and open structure of both soil and subsoil, less well adapted to farming without irrigation than are the normal sands of these series. Under irrigation it requires more water and more frequent irrigation and heavier fertilization than the sands, although in crop adaptation it is similar to the normal soils.

Barron coarse sand.—The soil material is usually from 12 to 24 inches deep, but may extend to the depth of 6 feet or more with but little variation in character of the material. It carries an excessive amount of fine angular granitic

fragments of the size of coarse sand and fine gravel. Beneath this surface stratum occurs a yellowish-brown, sticky clay loam derived from the underlying shale, which, however, is seldom encountered at a depth of less than 6 feet. Rock outcrop is rare. The type is friable and easily tilled. Drainage is ordinarily good and the soil retentive of moisture under cultivation. The type is adapted to small fruits and to apples, pears, peaches, and cherries.

Fresno coarse sand.—The type consists of a light-gray to yellowish-gray coarse sand, becoming light brown in the lower portion of the soil section and extending to a depth of 6 feet or more. It occurs as narrow or irregular bodies, often of small extent, occupying sloping or nearly level valley plains. Like the other members of the Fresno series, it is underlain by alkali hardpan, usually below a depth of 6 feet.

Drainage is ordinarily well established, although lower lying bodies would, under irrigation, accumulate seepage waters. The type is not retentive of moisture nor as well adapted to dry-farming methods as the other members of this series. Under favorable conditions of irrigation, peaches, vines, fruits, and alfalfa could be grown.

Hanford coarse sand.—The type consists of 6 feet or more of coarse micaceous sand ranging in color from light brown to grayish brown. Bodies lying immediately adjacent to stream courses or to other types of coarse texture carry fine water-worn gravel. The type occurs as scattered bodies of elongated outline occupying valley plains and often found adjacent to stream channels. It is of minor agricultural importance, owing to its coarse texture and lack of irrigation.

Area and distribution of the coarse sands.

Soil name.	State or area.[1]	Acres.
Hanford coarse sand	California 11	9,216
Barron coarse sand	Oregon 4	6,528
Fresno coarse sand	California 11	1,280
Total		17,024

[1] For key to numbers in this column see p. 733.

LOAMY COARSE SAND PHASE.

This should properly be considered as a phase of the coarse sand. In this province it has been recognized only in a single area occurring under arid conditions and as a member of the Fresno series. It carries a greater amount of fine mineral fragments than the coarse sand member of the series and is more retentive of moisture. It is better adapted to dry-farmed crops and requires less water for efficient production of irrigated crops. The crop adaptation under irrigation is practically the same, but owing to lack of these facilities and to local conditions of poor drainage forcing the accumulation of alkali salts over portions of the area it has not been developed to any extent and is utilized mainly for grazing or dry farmed to grain.

Fresno loamy coarse sand.—The type consists of a grayish coarse loamy sand, from 1 to 6 feet deep, carrying a large amount of very fine sand. The color becomes slightly darker in the lower part of the soil section. The type is fairly uniform in character, except where it merges into surrounding soils. It is underlain by the bluish calcareous alkali hardpan characteristic of the Fresno series. It occupies gently sloping valley plains, the surface being uniform, except for occasional sloughs, stream channels, or evidences of erosion. The higher lying or deeper phases are well drained and under irrigation are well adapted to the production of grapes, alfalfa, peaches, figs, and small fruits. The lower lying phases or those in which the hardpan closely approaches the surface are frequently poorly drained and subject to the accumulation of alkali, or swampy, and devoted principally to grazing. Owing to the presence of a much larger amount of very fine sand, the type is generally better adapted to the production of dry-farmed grains than is the Fresno coarse sand.

Area and distribution of the loamy coarse sand.

Soil name.	State or area.[1]	Acres.
Fresno loamy coarse sand	California 11	41,344

[1] For key to number in this column see p. 733.

Fine Sand Group.

The soils of the fine sand group are subject to much the same limitations and modifications through natural or artificial conditions as are those of the sand group. They are almost equally well suited to the production of watermelons, peaches, and the early truck crops, and are in general to be preferred for the production of general truck crops, grapes, apricots, early cherries, and other fruits, beans, and muskmelons. In favorable situations hardy vegetables may, with irrigation, be grown the year around. The group is also better suited to the production of alfalfa than the sands, but, except in the more moist coastal districts, it is not generally adapted to agriculture without irrigation. Owing to lack of irrigation facilities the grains are sometimes dry farmed, the yield being light and failures frequent except in favorable seasons. In the more humid sections along the coast potatoes, pumpkins, and root crops are successfully grown, to a certain extent without irrigation.

The soils of this group should be ranked with those more highly esteemed for the production of early truck crops and the stone fruits.

Fresno fine sand.—The soil is a gray, buff, or light-brown, smooth, micaceous fine sand, slightly sticky when wet, and of loose, porous structure. The soil is generally 6 feet or more in depth, but is sometimes less, and in such cases is underlain by a light-gray loam or sandy loam of fine ashy texture, frequently carrying alkali carbonate concretions or hardpan. The surface is smooth to slightly broken and uneven. The type covers extensive areas or occurs as long, narrow bodies. Drainage is generally good. Under irrigation alfalfa, truck, and fruits can be successfully grown.

Hanford fine sand.—The soil is a light-buff, yellowish, or light-brown, micaceous fine sand, 6 feet or more in depth. It is generally underlain by sand, fine sandy loam, or loam. The soil is usually free from gravel or other coarse material, has a loose, porous structure, and a peculiar smooth, greasy feel imparted by the high content of mica. The type consists of recent river deposits covering low delta plains and occurs as irregular, elongated, and sometimes slightly elevated ridges near former or present stream channels. The low-lying areas are often poorly drained and marked by willows or other timber growth in the vicinity of streams. The higher areas are well drained. When properly irrigated and drained it is a valuable soil for alfalfa, potatoes, root crops, and fruits.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Hanford fine sand	California 1, 4, 9, 10, 11	119,234
Fresno fine sand	California 13, 23	13,568
Total		132,802

[1] For key to numbers in this column see p. 733.

Sandy Loam Group.

Soils of the sandy loam group occur most extensively in the southern half of the Great Interior Valley of California and in the local valleys and alluvial-fan slopes near the coast in the southern part of that State. Unimportant types are found in northern California and southern Oregon.

In the more northern areas the sandy loam soils of the province are utilized mainly for grazing or the production of grains, although under irrigation they are adapted to peaches, cherries, almonds, and other fruit crops, and truck.

In some local areas where mapped such products may be grown without irrigation. The extensive areas of the sandy loam group in the San Joaquin Valley are extensively devoted to the production of table, raisin, and heavy-wine grapes, medium-early truck crops, melons, berries, and stone fruits, chiefly peaches, apricots, and prunes. Citrus fruits and cherries are grown to a limited extent, but the latter are successfully and more extensively grown in the coastal valleys. The citrus-fruit industry has not been developed to any degree of importance upon soils of this group in the interior of the State. Pears constitute an important crop in the less well drained localities, although the production of this crop in the interior valleys has been greatly curtailed by the blight.

Alfalfa constitutes an important crop and gives fair yields with copious irrigation. In the districts south of the Great Interior Valley citrus fruits are grown successfully, while in the vicinity of the coast, particularly in the Ventura district, lima beans and sugar beets are extensively produced. The soils are rather light textured to produce maximum results with the sugar beet or other root crops. In the more southern and coastal districts of California grapes, truck crops, and deciduous fruits also constitute characteristic products of the sandy loam soils.

The group is usually superior to the lighter soils in power to retain moisture during periods of drought, but is not generally well adapted to fruits or grains, forage, or other general farm crops except under irrigation. It is of greatest value in the production of moderately early fruits and truck crops under intensive cultivation, and for use in a light type of general farming combined with dairying, stock raising, or the production of special crops. Areas of soils of this group in which moisture conditions are favorable are used for the production of grapes and deciduous fruits without irrigation.

Barron sandy loam.—The soil is gray to grayish brown and from 12 to 30 inches deep. The subsoil consists of brown or yellowish-brown clay loam, grading into partially decomposed shale below 3 feet. The soil represents alluvial deposits, mainly granitic material, laid down by intermittent streams or as alluvial slopes lying below soils of the Siskiyou series. The subsoil is largely of residual origin, from shales. The type is not farmed to any extent, although suitable areas can be used for the production of fruits and apples.

Bellavista sandy loam.—This is a variable type, but consists principally of a light, ashy-gray, sandy loam, from 1 to 3 feet deep, underlain by a compact sandy clay of adobe structure, often containing gravel. It occupies level, gently sloping, or slightly depressed valley plains, and is ordinarily well drained. The soil material is derived from the erosion of beds of volcanic ash and tuffs mixed with gravel distributed by intermittent streams. It is mostly devoted to grazing or dry farming of grains.

Exeter sandy loam.—The type consists of a dark-brown or reddish-brown sandy loam 6 feet or more in depth, containing considerable gravel, somewhat sticky when wet and inclined to bake when dry. No hardpan occurs in this type. The surface is remarkably level and free from hog wallows. The type is of alluvial origin and is found along the stream courses. The material is mainly formed of wash from the surrounding San Joaquin soils with an admixture of some material from the Portersville soils. It is very productive and easily irrigated, both gravity and pumping systems being employed. All citrus and deciduous fruits, grapes, berries, truck crops, and alfalfa thrive.

Fresno sandy loam.—The soil consists of a light-brown to gray compact sandy loam from 3 to 6 feet deep, containing considerable coarse sand. It is sticky and inclined to puddle when wet, but proves friable if cultivated under proper moisture conditions. The subsoil consists of a fine, compact gray sandy to silty loam grading with depth into a white alkali carbonate harpan. The topography is nearly level to slightly sloping and the type is known locally as "white-ash" land. The lower lying bodies are often poorly drained. Seepage of irrigation waters often makes the land boggy and favors the accumulation of alkali salts. It is an excellent soil for alfalfa, vines, and fruits when well drained and irrigated.

Hanford sandy loam.—The soil is a grayish, micaceous sandy loam of medium to rather fine texture, 6 feet or more in depth, and friable and easily cultivated when moist. The type occurs as irregular bodies or narrow strips, and represents a mixture of the coarser sandy Hanford material with finer alluvium. It is sometimes slightly impregnated with alkali and suffers from accumulations of seepage waters. It is considered a valuable soil for the production of grapes, pears, prunes, and other fruits.

Maricopa sandy loam.—The type consists of a medium to rather fine textured light-gray to brown sandy loam 6 feet or more in depth, and underlain by a compact sandy loam of adobe structure, often marked in the lower portion by layers of sand, sandy loam, or silt loam. The soil is loose and friable under cultivation. The type consists of colluvial and partially assorted alluvial material covering mountain footslopes, sloping plains, débris aprons, and sloping valley plains formed by wash from secondary fan deltas. The soil is usually well drained and free from alkali. Where irrigated it is adapted to fruits and general farm and truck crops.

Oxnard sandy loam.—The soil consists of a brown to black sandy loam, generally of loose, open structure, but sometimes compact and with a tendency to break into clods. It is from 4 to 5 feet in depth and is underlain by a heavy, sandy loam or loam. The type is derived mainly from sandstone and shale and occupies gently sloping alluvial fans, elevated plains, and rolling hills. Small gravelly areas occur in the more elevated locations. In the lower lying situations the surface soil contains large accumulations of organic matter. Where free from alkali, the type is adapted to lima beans, grains, and sugar beets, and where favorably located it is a good soil for fruits. Drainage is generally well established, except over local areas, which often contain harmful accumulations of alkali salts.

Placentia sandy loam.—The soil is a coarse, compact, reddish-gray to reddish-brown sandy loam from 1 to 4 feet deep, rather sticky when wet, and containing considerable sharp sand and fine gravel. The subsoil is a compact, adobelike, red sandy loam or heavy loam sometimes grading into a sandy loam of somewhat looser structure in the lower part of the soil section. The type occupies rolling, hilly to gently sloping, or nearly level areas, in places only slightly elevated above more recent alluvial deposits. Under irrigation the soil is adapted to alfalfa and fruits.

Sutter sandy loam.—The soil consists of from 30 inches to 6 feet or more of a dark-brown, rarely black sandy loam. When less than 6 feet deep the soil is underlain by a brown or yellow sticky loam. The surface soil often carries a considerable amount of sharp angular rock fragments. Drainage over the greater part of the type is good, although small areas are occasionally flooded during the rainy season. The soil consists of alluvial-fan material washed from the slopes of adjacent hills and subsequently modified by flood waters. The soil material is derived mainly from andesitic rocks, tuffs, and breccias. No alkali is found in this type. It is used mainly for grain which is sown for hay. Fruits should do well. Alfalfa yields from 4 to 6 tons per acre without irrigation. Peaches and almonds are successfully grown.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Fresno sandy loam	California 13, 23	117,568
Hanford sandy loam	California 4, 11, 15	94,548
Oxnard sandy loam	California 19, 24	75,600
Placentia sandy loam	California 1, 19	66,688
Maricopa sandy loam	California 9, 19	37,312
Sutter sandy loam	California 12	11,264
Bellavista sandy loam	California 17	3,328
Exeter sandy loam	California 15	2,240
Barron sandy loam	Oregon 4	1,792
Total		410,340

[1] For key to numbers in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loam phase of the sandy loam group has been recognized in three areas, one of which occurs in the Olympic Peninsula in Washington and the other two in the semiarid plains of the Sacramento Valley in California. In no case in which this phase occurs has the true sandy loam of the same series been recognized. It is possible that the dominant agencies in the formation of these soils are such that the sandy-loam members will in all cases be characterized by the occurrence of gravel, constituting the gravelly sandy loams.

The gravel content normally increases the porosity of the soil structure and renders the crops grown more susceptible to drought. In the case of the Sequim gravelly sandy loam in northwestern Washington this feature is so marked that the type can be profitably farmed only under irrigation. It presents the anomaly of being devoted to hay, forage, and fruit crops, and potatoes under irrigation in an area subject to humid climatic conditions.

Where heavy subsoils exist the soils of this group, even in areas of deficient rainfall, are retentive of moisture and as well adapted to the production of nonirrigated crops as are the normal soils of the group under similar conditions.

In considering the purposes to which the gravelly sandy loams are adapted, the character of subsoils is of even more importance than climatic environment.

Arbuckle gravelly sandy loam.—The type consists of a grayish or light-brown gravelly sandy loam from 18 to 36 inches deep, underlain by reddish-brown gravelly clay loam. The light texture of the surface soil and the heavy, compact character of the subsoil causes a more or less boggy condition during wet weather and early in the spring, the surface often becoming somewhat hard and compact upon drying. The topography varies from flat to undulating, the surface being often broken by deeply eroded stream channels or sloughs. In the vicinity of streams a growth of blue oak, digger pine, and chaparral occurs. The soil is utilized for the production of grain and a limited area is cultivated to grapes without irrigation. The deeper phase of the soil is well adapted under irrigation to the production of fruits, vegetables, and vines.

Sequim gravelly sandy loam.—The soil consists of a dark-brown to black loam or heavy sandy loam 12 to 15 inches deep, containing a large amount of glacial gravel and stones. The subsoil is a dark-brown to black heavy sandy loam, which grades at 20 to 30 inches into a lighter-colored material containing a high proportion of cobbles and gravel. The subsoil is usually more gravelly than the soil. Below 30 inches and sometimes at a lesser depth, the cobbles and gravel are mixed with a high percentage of fine rock flour, which, when saturated with water, cements into a hard mass, thus preventing the downward passage of water. Over the greater part of the type the stones and bowlders are present in sufficient numbers to interfere seriously with cultivation. Where the land is cropped they have usually been removed. Nearly all of this type near Sequim has been placed under irrigation with excellent results. The crops grown consist of clover, oats, Canada field peas, and alfalfa. Apples, pears, cherries, plums, strawberries, blackberries, and raspberries are also grown. Oats yield 60 to 85 bushels per acre and potatoes 200 bushels per acre.

Yolo gravelly sandy loam.—The type is of loose, open structure and light-brown color. The subsoil is similar to the soil in color, texture, and structure. Both soil and subsoil material contain a large amount of rounded or flattened gravel of dark-colored metamorphic rocks. The type is of alluvial origin, deposited as stream-outwash material upon sloping valley plains. The material forming the type is derived mainly from metamorphic rock. It is well drained, poorly supplied with organic matter, and deficient in power to hold moisture. Under copious irrigation it is adapted to vegetables and fruits.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Arbuckle gravelly sandy loam	California 25	24,000
Yolo gravelly sandy loam	California 2	11,840
Sequim gravelly sandy loam	Washington 5	2,304
Total		38,144

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loam soils of this province are, so far as mapped, represented by a single type occurring in the arid portions of the interior valley of California.

The type is more porous than the sandy loam soils of the province and less able to withstand long-continued drought or neglect of irrigation or cultivation.

In crop adaptation it is intermediate between the sand and the sandy loam groups.

Hanford coarse sandy loam.—This type consists of 6 feet or more of a light-brown or buff-colored micaceous coarse sandy loam. It occurs as scattered bodies of irregular outline upon valley plains, and in origin and mode of formation is similar to the other members of the Hanford series. The surface is generally level and the type is free from alkali. It is somewhat better adapted to the production of grains under dry-farming methods than is the Hanford coarse sand, and under irrigation it is well adapted to alfalfa, peaches, and grapes.

Area and distribution of the coarse sandy loam.

Soil name.	State or area.[1]	Acres.
Hanford coarse sandy loam	California 11; Oregon 4	3,584

[1] For key to numbers in this column see p. 733.

SANDY LOAM ADOBE PHASE.

The sandy loam adobe, so far as it has been mapped, is confined to the more arid portions of the interior valley of California and to the southern California districts. It will probably not be encountered except under conditions of restricted rainfall.

Owing to peculiar characteristics of structure the soil has a high water-holding capacity and is retentive of moisture under conditions imposed by long-continued drought. This effect is such as to place the soil in its adaptation to crops in the loam or clay loam group. It constitutes a fair general-farming type, both with and without irrigation, and while an excellent soil for deciduous or citrus fruits with favorable climatic conditions and irrigation, is less well adapted to early fruit products than is the sandy loam.

Placentia sandy loam adobe.—The type consists of a dense, compact, and tenacious reddish-brown or red sandy loam adobe from 3 to 6 feet deep, carrying considerable quantities of coarse angular sand or fine gravel. It is underlain by lighter loams or sands of loose porous structure. The soil is refractory, and tends to check and crack upon exposure. It is often overlain by a few inches of sticky, compact sandy loam, which grades into the stiff, dense adobe structure of the typical soil. The type occurs in small to extensive areas covering mesa lands and remnants of elevated sloping valley plains. Alkali is occasionally present in small quantities. Drainage is well established and the soil retentive of moisture. The type is dry farmed to grains or used for alfalfa or fruits under irrigation.

Area and distribution of the sandy loam adobe.

Soil name.	State or area.[1]	Acres.
Placentia sandy loam adobe	California 1, 22	36,454

[1] For key to numbers in this column see p. 733.

FINE SANDY LOAM GROUP.

The fine sandy loams of this province occur under a wide range of climatic conditions. Limited areas are encountered in the extreme northwestern part of the province, heavily forested and subject to unusually heavy precipitation. Other areas of small extent are found under subhumid conditions in southern Oregon. The more extensive and important types, however, occur throughout the southern two-thirds of the great interior valley, in the coastal valleys, and along the southern coastal margin and valleys of southern California, where the climate is semiarid or arid. Some of these areas are extensively utilized for agriculture without irrigation, the soils of this group being usually retentive of moisture.

The group, considered as a unit, is, in the absence of irrigation facilities, adapted to general farming. Where capable of irrigation it can be more profit-

ably employed for the production of special crops, such as fruits and late truck or forage crops and alfalfa in connection with stock raising or dairying. In the nonirrigated regions most of the deciduous fruits and garden vegetables may, with careful cultivation, be grown for home use. Commercial fruit and vegetable production, without irrigation, except in the more northern areas or in the moist coastal valleys subject to summer fogs and cool moist winds, is uncertain. Grapes, grown mainly for table use or for the manufacture of wines, are successfully grown without irrigation throughout the districts of limited rainfall and of high summer temperature, and in local areas peaches, apricots, and almonds are similarly produced.

In the northwestern humid areas the group is devoted mainly to oats, hay, and dairying, but is also adapted to apples, berries, and staple truck crops. In the subhumid regions of southern Oregon it is adapted to the culture of apples, pears, and cherries, both with and without irrigation. In the more northern portion of the interior valley of California it is utilized mainly for the production of wheat and barley, but under irrigation is adapted to and yields more profitable returns when devoted to alfalfa, deciduous fruits, such as plums, prunes, grapes, berries, and truck crops. In the southern half of the interior valley the fine sandy loams include leading soils for the production of pears, plums, cherries, figs, prunes; table, wine, and raisin grapes; apricots, late peaches, small fruits, melons, sweet potatoes, and other medium early to late vegetables. The group is also profitably devoted to alfalfa, dairying, forage crops, and sometimes to grains. In the coastal valleys the soils of this group are less extensively devoted to alfalfa and forage crops, being used preferably for cherries and other deciduous fruits, English walnuts, and, in the vicinity of the cities, truck crops. In some of the nonirrigated sections of the coastal valleys grains are extensively grown. In the more southern coastal valleys and alluvial-fan slopes the fine sandy loams are utilized mainly in connection with a highly developed intensive system of agriculture and are highly esteemed for the culture of citrus fruits, truck crops, winter vegetables, and the deciduous fruits. Areas incapable of irrigation are devoted to grain and in favorable locations to grapes.

The group should be rated as essentially adapted to citrus and the later stone fruits, truck crops for market or for preserving or canning purposes, and to alfalfa and the lighter type of general farm crops. Sugar beets have been grown upon these soils only to a small extent, but should prove moderately successful. The agricultural value of the soils of the group is sometimes impaired by poor drainage and the occurrence of alkali salts.

Arbuckle fine sandy loam.—The type consists of a gray to brown fine sandy loam, underlain by a brown to reddish-brown fine sandy loam or sandy loam becoming yellowish brown in the lower portion and often marked by stratified deposits or silty material. The average texture of the 6-foot section is a fine sandy loam. Pockets or strata of gravel are often encountered at various depths. The topography is comparatively level and the soil as a whole is well drained. Where irrigated it is well adapted to the production of truck crops and fruits.

Bellavista fine sandy loam.—The type is of light ashy-gray color, sticky and porous, and 6 feet or more in depth. It carries a large amount of water-worn gravel and pumice cobbles. The soil material is derived mainly from basaltic rock and pumice stone. The type is generally timbered. Only inextensive areas have been mapped. It is adapted to apples and pears.

Dungeness fine sandy loam.—The soil consists of a gray to light brownish gray, silty, fine sandy loam of close, compact structure, about 12 inches deep. It contains more organic matter than the Dungeness silt loam and is slightly darker colored. The subsoil from 12 to 36 inches varies from a yellowish-gray fine sandy loam to a compact gray silt loam. Frequently both soil and subsoil are marked with reddish-brown iron stains. The type represents glacial outwash material. It is easily worked, but has a tendency to run together if plowed when too wet. The topography is uniformly level, with sufficient slope to insure good surface drainage. The greater part of the type could be profitably irrigated. Only a small area is under cultivation, although over much of it the forest has been removed. Oats, clover, alfalfa, and grasses are grown. In addition to these crops, apples, blackberries, raspberries, strawberries, and truck crops could be grown.

Fancher fine sandy loam.—The soil consists of a reddish-brown, micaceous fine sandy loam 6 feet or more in depth, of friable and porous structure, and sometimes gravelly. The type is derived from rather recent alluvial material deposited by foothill streams, and occurs as small bodies about minor stream

sinks, flood plains, or gently sloping valley plains. Drainage is fairly good. It is an excellent soil for fruits and general crops.

Fresno fine sandy loam.—This is a light-gray, compact, fine sandy loam, rather sticky when wet, and readily puddled. The soil is generally 6 feet or more in depth, with the lower portion of the soil section frequently of a somewhat lighter texture. It is marked at a depth of from 2 to 4 feet by a stratum of heavy, dense, white calcareous hardpan containing alkali carbonates. The type occurs as irregular bodies near the margin of valley plains. The surface varies from level to slightly depressed. Drainage is poor and alkali accumulations prevalent. Where well drained and properly irrigated and cultivated the type is adapted to fruits. Alfalfa can be grown where the underlying hardpan does not too closely approach the surface.

Hanford fine sandy loam.—The type is a light-gray, light-brown, or buff to dark-drab micaceous fine sandy loam, 3 to 6 feet or more in depth, of porous to moderately compact structure, the underlying material grading from loose sand to heavy loam. The soil material is composed of recent deposits of river flood and delta plains. The surface is generally low, level, and frequently timbered or covered with willows and brush. In the vicinity of lower depressions and flood plains of larger streams it is sometimes deficiently drained or subject to overflow where not protected by levees. The soil is generally productive under cultivation where well drained and free from alkali. Where favorably situated it is adapted to alfalfa, general farm crops, fruits, English walnuts, small fruits, asparagus, celery, and truck crops.

Maricopa fine sandy loam.—The soil is a light-brown to dark-brown, loose, porous, fine sandy loam, from 3 to 6 feet or more in depth, containing considerable water-worn gravel. It is underlain by sands and rounded gravels, sometimes cemented into a calcareous hardpan. The type consists of torrential stream deposits occurring upon mountain foot slopes, mesa lands, and upper valley plains, frequently more or less modified by subsequent weathering and the addition of alluvial wash. Drainage is good and the soil is well drained and free from alkali. Under irrigation it is adapted to alfalfa, grains, citrus, deciduous, and small fruits.

Medford fine sandy loam.—The soil is light brown in color and from 12 to 30 inches deep. It is underlain by a darker brown subsoil carrying conspicuous amounts of fine angular granitic particles giving a texture approaching a coarse sandy loam. The surface is usually of good slope and well drained. The type supports a heavy growth of pine, oak, and laurel. It is somewhat deficient in moisture-retaining capacity, but is well adapted to peaches, cherries, and apples. Pears are grown with fair success, but are better suited to the heavier soils.

Oxnard fine sandy loam.—The soil is a greenish-gray, rather sticky, micaceous fine sandy loam 12 to 24 inches deep, underlain by a rather heavy, sticky gray sandy loam or loam. The sand particles are fine and the sand has a greasy, soft feel. If plowed dry the soil breaks up into large clods, but when moist it is loamy and easily cultivated. The surface is smooth and level. The type is derived from the weathering of an argillaceous sandstone. The greater part of the type is well drained, but some portions contain alkali, owing to inadequate drainage. The soil is well adapted to wheat, and with irrigation should produce good yields of alfalfa.

Placentia fine sandy loam.—The soil is a light yellow to grayish-brown or reddish-brown, sticky, somewhat plastic loam of fine sandy texture and of rather compact structure from 15 inches to 3 feet deep. It is inclined to puddle and bake and when dry breaks into clods, but is friable when plowed under proper moisture conditions. Coarse, sharp sand and sometimes small quantities of rather fine angular or partially rounded gravel are present in the surface soil. The subsoil consists of a stiff, tenacious red sandy clay or heavy loam, compact, impervious, and approaching a hardpan or adobe structure. It checks upon exposure, and is sometimes penetrated with difficulty by tender roots. In places it shows a gray to drab color, and where exposed gives rise to the adobe soils of the Placentia series. Occasionally the soil reaches a depth greater than 3 feet or is underlain by sandy loam or loams of less dense, compact structure. This type consists mainly of colluvial soil creep and of wash from torrential and intermittent streams, and occasionally over small areas of residual material. The type occurs as extensive areas covering sandstone and granitic foothills and mountain footslopes, delta fans, and sloping valley plains. The higher lying bodies are frequently rough, broken by rock outcrop, deeply cut by ravines and arroyos, and lie above the reach of irrigation waters. The soil is productive, easily irrigated, and is devoted to grains, citrus and deciduous fruits,

walnuts, grapes, alfalfa, and general farm crops. The type is one of the important orange soils of California.

Poplar fine sandy loam.—The soil consists of a light-brown or buff-colored micaceous fine sandy loam varying in depth from 24 to 48 inches and underlain to 6 feet or more by a reddish to yellowish-brown heavy loam or light-clay loam. The soil material is of alluvial origin, derived from granitic rocks, and is similar to that of the Hanford series. The subsoil consists of material of the San Joaquin series, more or less modified by weathering. The red iron hardpan characteristic of the San Joaquin series is seldom encountered within a depth of 6 feet. Where this type occurs near the San Joaquin soils drainage is somewhat deficient and the surface soil inclined to be heavy. Where surrounded by the Hanford soils the surface soil approximates somewhat the Hanford fine sandy loam. It is an excellent alfalfa, fruit, and truck soil.

Ulmar fine sandy loam.—The soil consists of a loose, friable, brown to light-brown, medium to fine sandy loam, sometimes tinged with red, varying in depth from 2 to 6 feet. It is underlain by a slightly lighter colored, coarser sandy loam of heavier texture, which in turn rests upon a yellowish sandy hardpan. The surface is marked in many places by hog wallows or interrupted by old stream channels. The type is formed principally by modifications of the material giving the Ulmar loam, through the addition of colluvial and alluvial material washed from adjacent bodies of Contra Costa sandy loam. Alkali salts are often present, sometimes in considerable quantities. The vegetation consists of greasewood and salt grass. The type is extensively devoted to grazing. Some portions are utilized for dry farming to grain and hay with light yields.

Yolo fine sandy loam.—This type consists of 15 inches or more of rather light fine sandy loam of light-brown color, underlain by brown sand or fine sandy loam frequently marked by strata of loam, silt loam, or sand. In the vicinity of overflow basins the subsoil is sometimes a clay. A thin mantle of wind-blown sand or of silty material is sometimes present. Occasionally the soil extends to a depth of 6 feet. The surface is level to slightly undulating and the soil well drained and retentive of moisture. Willow, cottonwood, and alder grow along the streams. The type is formed of recent alluvial deposits by intermittent foothill streams. It is largely devoted to dry-farmed grains, but is adapted to a wide range of crops, alfalfa, peaches, apricots, almonds, grapes, sugar beets, and truck crops being successfully grown.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Placentia fine sandy loam	California 9, 10, 19, 20, 21, 22	371,433
Hanford fine sandy loam	California 1, 4, 9, 10, 11, 15, 19, 20, 22	208,602
Fresno fine sandy loam	California 3, 4, 11, 13, 23	202,143
Oxnard fine sandy loam	California 19	22,848
Yolo fine sandy loam	California 2, 25	18,432
Fancher fine sandy loam	California 3	12,832
Dungeness fine sandy loam	Washington 5	8,960
Maricopa fine sandy loam	California 9	5,952
Poplar fine sandy loam	California 15	5,632
Medford fine sandy loam	Oregon 4	3,456
Arbuckle fine sandy loam	California 25	3,200
Ulmar fine sandy loam	California 8	832
Bellavista fine sandy loam	Oregon 4	576
Total		864,898

[1] For key to numbers in this column see p. 733.

GRAVELLY FINE SANDY LOAM PHASE.

The gravelly phase of the fine sandy loam group has been recognized in but one locality, occurring under subhumid conditions.

The soil is somewhat deficient in power to retain moisture during periods of drought, but under irrigation or intensive cultivation does not differ essentially in its adaptation to crops from the normal fine sandy loams.

Medford gravelly fine sandy loam.—The soil is brown to light brown in color, of slightly micaceous character, and from 10 inches to 2 feet deep. It contains varying amounts of water-worn to subangular gravel. The subsoil is brown to nearly black and of rather compact structure and moderately heavy texture.

It frequently contains fine angular fragments of light-colored granitic rock. The type is utilized mainly for the production of alfalfa, but is also well adapted to apples, pears, and small fruits.

Area and distribution of the gravelly fine sandy loam.

Soil name.	State or area.[1]	Acres.
Medford gravelly fine sandy loam	Oregon 4	320

[1] For key to number in this column see p. 733.

LOAM GROUP.

The loams of the alluvial fan and recent valley filling material of the Pacific coast region have been mapped under a considerable range of climatic conditions. The more northerly and humid areas mapped occur in southern Oregon, where irrigation is practiced only as supplementary to the natural rainfall. Other areas occur in the nonirrigated coastal districts in California, where the crops are subject to less extremes of heat and aridity than obtain in the interior valleys and where, though little or no rain falls during the summer season, the effects of droughts are ameliorated by fogs and cool, moist winds. The group is found most extensively developed in the Great Interior Valley. Important but somewhat less extensive areas occur in the semiarid to arid districts of southern California.

The soils of this group are usually retentive of moisture unless underlain by heavy and impervious subsoils or substrata. The texture is, moreover, such as to favor cultural operations under normal conditions of drainage, while the soil possesses the more compact properties of the heavier soils and requires less frequent and copious irrigation and less constant cultivation than the types of the lighter groups. Their adaptation to general farm crops is apparent, the production of early fruit and of truck crops being of less importance. Hay crops, consisting of timothy and the clovers, where temperature and moisture conditions are favorable, as well as alfalfa, are profitable. Of the fruits, pears, plums, and prunes are most successfully and widely grown, although almonds, apricots, and peaches for the later market or for drying or canning purposes maintain an important rank in the products of intensively cultivated areas.

Later maturing vegetables, consisting of cabbage, cauliflower, onions, beets, etc., as well as small fruits, are grown for local markets or for shipment. Tomatoes and other products grown most profitably on the lighter soils for early market yield larger returns when grown on the loam soils for later market or for canning purposes. In the coastal valleys, subject to favorable climatic conditions, cherries, lima beans, English walnuts, and fall and early winter apples are important crops. Wine, table, and raisin grapes are produced in commercial quantities, and figs and olives are grown to some extent. In the more southern districts the loams constitute important citrus-fruit producing soils, while nearly all the deciduous fruits and vegetables of the more northern districts are grown with good results.

The soils of this group fulfill the requirements of general purpose types upon which general farming, dairying, the culture of nearly all fruits and vegetables for home use, or the commercial production of the later stone fruits or of apples, pears, citrus fruits in favorable localities, and staple truck crops and small fruits, may be undertaken. Poor drainage conditions and excess of alkali salts are somewhat more common than upon the soils of the preceding group.

Arbuckle loam.—The soil consists of a light-brown to reddish-brown friable loam 24 to 30 inches deep. The subsoil consists of a brown or reddish-brown sandy loam or loam, often grading in the lower lying bodies into a clay loam or clay. A small percentage of gravel is usually present in both soil and subsoil. The topography is sloping to slightly rolling and drainage well established. The soil is often marked by the presence of a plow sole at a depth of 4 to 5 inches. Grain is the principal crop, but raisin grapes and almonds have been grown to a limited extent. The type is favorably situated for irrigation, and is well adapted to alfalfa, grapes, deciduous fruits, kafir and Egyptian corn, sorghum, and sugar beets.

Clawson loam.—The soil varies in depth from 3 to 6 feet and is often of compact and refractory structure, which gives it the characteristics of a heavier type in the field than is represented by mechanical analysis. Under favorable conditions of drainage it is fairly well adapted to pears, vegetables, and hay crops.

Corralitos loam.—This is a smooth, mellow, chocolate-brown, micaceous loam 3 feet in depth, underlain by a light-brown or yellowish-brown micaceous loam extending to a depth of 6 feet or more. It is uniform in texture, of good capillarity, free drainage, and excellent moisture-retaining powers. The type is of alluvial origin, being derived from the weathered product of shale rocks forming the adjacent hills, deposited by minor streams traversing alluvial fans or slopes or by sheet-wash. It is well suited to orchard and garden crops, particularly apples, prunes, and apricots.

Dublin loam.—The soil consists of a dark-brown to nearly black friable heavy loam, with considerable sand and enough clay to make it decidedly sticky, the structure approaching adobe in some places. It is underlain at depths ranging from 2 to 3 feet by a dark grayish brown, heavy loam or silty loam, extending to 6 feet. Pockets of sand or sandy loam, or thin strata of these, sometimes occur in the subsoil. The topography is comparatively level and drainage well established. A few oaks, with some willows and sycamores, occur along stream channels. The type is mainly dry-farmed to grain and hay. Fruit is grown to a limited extent with fair yields.

Esparto loam.—The type consists of a light-brown loam or silty loam, about 24 inches deep, underlain by a light-brown loam or clay loam. Both soil and subsoil are of compact structure, the soil being friable under cultivation. The type occupies valley plains. The surface is gently sloping, insuring good natural drainage. It is utilized extensively for the production of tree fruits, white wine grapes, apricots, almonds, plums, olives, and, to a small extent, for figs. Under irrigation it is also well adapted to alfalfa.

Fresno loam.—The soil is a gray to reddish-brown, compact and sticky heavy loam of very fine, smooth texture, from 3 to 3½ feet in depth. The lower portion of the soil section is marked by iron concretions and dense, impenetrable strata of calcareous alkali-carbonate hardpan, underlain by fine light-gray loam. The type occupies lower valley plains and slight depressions of smooth, level surface. It is frequently strongly charged with alkali and is poorly drained.

Hanford loam.—The type consists of a dark-gray or black micaceous loam, underlain at the depth of 2 to 5 feet by a heavy loam or light clay loam of yellowish or reddish-brown color. The soil sometimes approaches a clay loam in texture and represents recent alluvial deposits laid down in quiet water. The heavier reddish-brown subsoil consists usually of older Pleistocene sedimentary material giving the soils of the San Joaquin series. The type possesses well-developed moisture-retaining properties and is adapted to the production of grapes and small fruits.

Medford loam.—The soil is brown to dark brown, slightly sticky when wet, and from 16 to 40 inches deep. The subsoil is a heavy, compact clay loam of grayish-brown to dark-brown color, often containing numerous small angular granitic fragments of light color. The surface is uniformly sloping and well drained. It is retentive of moisture and adapted to alfalfa, apples, pears, etc.

Modesto loam.—The type consists of grayish to chocolate-brown loam carrying coarse sharp quartz or granitic sandy material as a characteristic feature with a relatively large amount of silt. It is underlain at a depth of 12 inches by a heavy loam or clay loam of adobe structure, marked by the presence of coarse sharp sand, which is in turn underlain at 3 to 5 feet by the gray, silty calcareous subsoils of the Fresno series, often cemented into a calcareous hardpan. This soil is probably formed by deposition from older stream channels subsequently modified by water through deficient drainage. The type is subject to considerable variation in texture, and small amounts of alkali often occur in the heavier soil bodies, imparting a dense structure and puddling tendencies to such areas. The surface is often uneven and marked with "hog wallow" or other small mounds and depressions. The bodies of lighter texture are usually more elevated, better drained, deeper, and of more nearly level surface. They are friable and easily cultivated, and are well adapted to the production of alfalfa, grapes, peaches, vegetables, and berries.

Oxnard loam.—The soil consists of a gray or dark-colored sticky loam, 3 to 6 feet or more in depth, sometimes of a compact, refractory structure. The type consists of the finer material derived from shales and sandstones and the

wash from higher-lying soil types or deposits from stream flood waters. It occupies level flood plains and higher sloping plains near the foothills. Drainage is generally good except over areas subject to overflow. Alkali is sometimes present. The type is generally devoted to lima beans and English walnuts.

Placentia loam.—The soil is a light-brown or reddish-brown loam, from 1 to 6 feet or more in depth, often gravelly, and of somewhat compact structure. It is underlain by a reddish-brown heavy loam of compact, dense, adobelike structure, or in small residual areas by disintegrating rock. The type is similar in topography, origin, mode of formation, and crop adaptation to the Placentia fine sandy loam, but has a somewhat finer and heavier texture.

Sunol loam.—The soil consists of a brown to reddish-brown heavy loam or light clay loam from 24 to 36 inches deep and carrying small amounts of angular rock fragments. It is underlain by a lighter brown loam or clay loam, becoming heavier in texture with depth. The surface is slightly sloping. The type consists chiefly of alluvial material, formed by stream sediments derived from soils of Pleasanton series. The topography is slightly sloping and the soil well drained and friable. It is farmed to hay and grain.

Sutter loam.—This type consists of 18 inches to 6 feet of a gray, sticky, loam often carrying considerable quantities of fine angular gravel, underlain by a dark-brown to black clay loam, frequently having many of the characteristics of the adobe. The soil is largely colluvial, derived from material washed from adjacent slopes and modified by alluvial agencies or overflows. Drainage is ordinarily good, as the type occupies gentle slopes. The soil is sometimes cultivated to grain which is used for hay, but the greater proportion of it is still uncleared.

Ulmar loam.—The type consists of a brown to dark-brown loam from 15 to 24 inches deep, underlain by a yellowish-brown sticky clay resting at 36 inches or more upon an impervious yellow sandy clay hardpan. The surface soil contains a large amount of sand, is spongy when wet, and inclined to puddle and crack unless cultivated under proper moisture conditions. The soil material is of colluvial and alluvial origin, derived largely from the brown soils of the Altamont series, and modified by material from the Contra Costa and Diablo series. The topography is comparatively level except where interrupted by stream channels or depressions. Percolation is retarded by the hardpan and drainage retarded by the flat surface. The soil is retentive of moisture. It is utilized chiefly for grazing or for hay and grain. Much of the land is now being sold in tracts and planted to small fruits and truck, which are successfully grown under irrigation or on bodies free from alkali.

Willows loam.—The soil is a slightly compact, friable, light-brown to light-gray loam from 10 to 18 inches deep, underlain by a compact, light-brown to light chocolate brown clay loam of compact, adobelike structure. The type occupies sloping valley plains near minor foothill streams, the surface often being somewhat uneven, eroded, and marked by hog wallow mounds. It is adapted to dry farming to grains and, under irrigation, to the production of alfalfa, sugar beets, vines, and fruits.

Yolo loam.—The soil is a dark-brown, light-textured silty loam about 24 inches deep and usually free from gravel. The upper part of the subsoil consists of a sandy silt loam resting upon a clay loam or clay, with occasional beds or pockets of gravel found at a depth of 4 to 6 feet. Both soil and subsoil are subject to decided variations in texture. The type occupies low, flat-topped or gently undulating ridges, or occurs as narrow strips bordering stream valleys. Natural drainage is good, except in the case of shallow depressions where water sometimes accumulates during a wet season. The type is free from alkali salts, is well adapted to a wide range of crops, and is devoted to general farm crops and to fruits, including peaches, almonds, prunes, and grapes.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Yolo loam	California 2, 13, 23, 25	49,920
Placentia loam	California 22, 24	25,710
Fresno loam	California 1, 13	21,376
Oxnard loam	California 19, 24	19,812
Arbuckle loam	California 25	18,304
Sutter loam	California 12	10,048
Modesto loam	California 13	8,896
Hanford loam	California 15	7,488
Willows loam	California 2, 25	6,720
Ulmar loam	California 8	3,584
Esparto loam	California 25	3,200
Medford loam	Oregon 4	2,560
Corralitos loam	California 14	1,408
Dublin loam	California 8	896
Clawson loam	Oregon 4	768
Sunol loam	Calfiornia 8	448
Total		181,138

[1] For key to numbers in this column see p. 733.

GRAVELLY LOAM PHASE.

The gravelly loam soils of the Pacific coast region derived from alluvial fan and recent valley filling material are of more widespread occurrence than the group phases previously noted. They occur under climatic conditions ranging from subhumid to strictly arid.

Owing to their pronounced gravel content they are of somewhat more porous structure, and are more easily maintained in a favorable condition of tilth but are somewhat less retentive of moisture than the loams. Drainage is ordinarily better and while adapted to many different crops, according to local conditions of temperature, precipitation, topography, and irrigation, in the general adaptation they are more like the soils of fine sandy loam or gravelly fine sandy loam texture than the normal loams. They are superior to the loams for the production of early products, but less well adapted to dry-farming products.

Arbuckle gravelly loam.—The soil consists of light grayish brown loam from 2 to 3 feet deep containing varying quantities of water-worn gravel. It is underlain by a reddish-brown loam or clay loam, slightly compact and carrying more or less gravel. It occupies slopes bordering streams or broad undulating areas slightly elevated above the general level of the country. The natural drainage is good. The soil is formed of the coarser material deposited by the flood waters of the streams traversing the valley plains. Grain is the principal crop, but fruits and raisin grapes are produced to some extent.

Coleman gravelly loam.—The soil is gray to brown, ranging from 12 to 24 inches in depth, and carries considerable quantities of subangular to water-worn gravel, the fragments ranging from 1 to 1½ inches in diameter. The subsoil is light brown and carries considerable gravel. The soil is well adapted to irrigation. It generally supports a growth of laurel, pine, oak, and brush where uncleared. It is low in organic matter, and is somewhat deficient in moisture-retaining capacity unless effectively cultivated. Under irrigation or effective cultivation it is well adapted to small fruits, peaches, apples, and pears.

Maricopa gravelly loam.—The soil consists of a light-brown to dark-brown or almost black sandy loam, grading in texture from coarse to rather fine, and 6 feet or more in depth. It is of loose, porous, and somewhat leachy structure, although over limited areas it assumes a somewhat compact structure in its virgin condition. It carries a considerable quantity of fine, subangular, or waterworn gravel, and where less than 6 feet in depth is underlain by sands or gravel and cobbles, sometimes cemented by lime into a hardpan. The type generally occurs as extensive bodies covering mountain footslopes, rolling foothills, and broad, abrupt to gently sloping débris aprons and fan-shaped plains. The type consists of colluvial and partially assorted alluvial wash and material distributed by torrential streams. It sometimes occurs as narrow bodies following the courses of minor intermittent streams. The surface is in some places irregular and often cut by arroyos and strewn with angular and rounded

bowlders. The type is derived mainly from granitic rocks. Drainage is established, and the type is free from alkali. Owing to its elevated position and its irregularities of surface, it is often incapable of irrigation and is devoted only to grazing or dry-farmed to grain or vine crops. In California extensive areas are irrigated and produce heavy yields of grains, grapes, and citrus and stone fruits.

Oxnard gravelly loam.—The soil consists of a heavy silt loam or a light clay loam ranging from dark brown to drab or gray, generally 6 feet or more in depth, and light and friable under cultivation. The lower portion of the section is usually of light gray color. The soil in many places is gravelly and carries considerable coarse sand and fine gravelly particles. The type consists mainly of colluvial and alluvial material deposited over sloping plains by torrential mountain streams. The materials are derived largely from siliceous and bituminous shales, the gravel being made up of light or light-brown chalky or flinty fragments. The soil is well drained, free from alkali, and is generally devoted to grains, particularly to barley and to lima beans and walnuts.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Maricopa gravelly loam	California 10, 19, 20, 21, 24	47,160
Oxnard gravelly loam	California 10, 24	16,270
Arbuckle gravelly loam	California 25	16,128
Coleman gravelly loam	Oregon 4	5,888
Total		85,446

[1] For key to numbers in this column see p. 733.

LOAM ADOBE PHASE.

The loam adobe soils of this province occur under conditions of semiarid or arid climate in the southern portions of the Pacific coast region. The adobe structure renders the soils of high moisture-holding capacity, but sticky when wet, and they readily puddle. Upon subsequent exposure they quickly bake and assume a compact refractory structure, except where the adobe structure is pronounced, and a finely granulated surface is produced by checking. While some times poorly drained, the soil is, under effective methods of tillage and artificial drainage where necessary, capable of being maintained in a good condition of tilth. In the uses to which the soil may be most effectively devoted it corresponds more closely to the soils of the clay loam than to the loam group and is best adapted to general farming requiring heavy farming equipment. Favorably situated areas are, however, under intensive methods of tillage, successfully devoted to the production of citrus fruits, olives, and in some cases to English walnuts, although the latter crop generally gives better results upon lighter and more friable soils.

Maricopa loam adobe.—The type consists of a dark-brown, compact, plastic and sticky adobe soil of loam texture, from 2 to 6 feet or more in depth and underlain by light-colored, compact loam adobe structure or by indurated sand or disintegrating granitic rock. The type consists mainly of colluvial material modified by recent weathering, erosion, and the addition of fine alluvial material washed from surrounding hills. It occupies rolling hills and sloping plains and is generally devoted to citrus fruits, grains, olives, walnuts, etc.

Stockton loam adobe.—The soil is usually black in color, consisting of a dense, sticky loam adobe usually black but including small grayish spots perhaps about 30 inches deep and carrying in many places angular rock fragments and light-colored coarse sand. It is underlain by a light-yellow or buff silty clay loam. The type is inclined to puddle and crack unless handled under proper moisture conditions. It is derived from old stream alluvium modified by the incorporation of large quantities of organic matter and by wash from adjoining soil areas. It occupies the lower valley plains and is sometimes partially timbered. Drainage is generally deficient. The type produces fair yields of general farm crops under careful cultivation.

Area and distribution of the loam adobes.

Soil name.	State or area.[1]	Acres.
Maricopa loam adobe	California 9, 19	16,320
Stockton loam adobe	California 23	2,560
Total		18,880

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

The silt loams of this province are encountered from the humid, heavily forested districts of the Olympic Peninsula in Washington to the arid desert valleys and slopes of southern California. They are of much less extent in occurrence than the soils of the fine sandy loam and loam groups.

Ordinarily they are of rather compact structure, being inclined to puddle and becoming hard and cloddy on drying out, making tillage operations difficult unless plowed under the right moisture conditions. Where well drained they are mellow and friable, working up readily into an excellent seed bed and easily maintained in good tilth. They are retentive of moisture unless allowed to puddle and bake, are well adapted to dry farming, and require a minimum amount of water under irrigation.

In this group of soils the general farm crops, such as the small grains, forage crops, including particularly sorghum, broom corn, and root crops, potatoes, and alfalfa, are successfully grown. Timothy and clover do well under favorable climatic conditions and are grown to some extent in the more northern areas. Dairying and stock raising are favored by the type of crops to which the soils are adapted. Corn is grown to a limited extent. Its place is taken by other crops better suited to the climatic conditions. Sugar beets have not been extensively grown, but the silt loam types of this province are well adapted to their production. Where irrigated, the soils are more profitably devoted to alfalfa, dairying, stock raising, or to the culture of special intensively cultivated crops. The cereals are grown extensively, usually without irrigation.

Where well drained the soils are also excellently adapted to stone and other fruits, such as prunes, pears, and cherries, while almonds, apricots, oranges, lemons, apples, and English walnuts do well. Vegetables intended for the later or winter markets or for drying or preserving are grown to some extent. The production of lima beans is a highly developed industry in certain of the coast districts of California. Hops and asparagus are successfully grown and are well suited to the soils of silt loam texture.

This group of soils is preeminently adapted to general farming, with the production of moderately heavy crops, the home production of fruits and vegetables, and the commercial production of certain tree fruits and late vegetables.

Arbuckle silt loam.—The soil is a yellow or reddish-brown loam 24 inches deep which usually contains a small quantity of water-worn gravel. It is friable when cultivated, but has a tendency to form compact surface crusts when in a dry or baked condition. The subsoil consists of a dark-red clay loam, loam, or sandy loam. The type occupies broad slopes near the base of lower foothills, and has good natural drainage. It is utilized principally for the production of dry-farmed wheat and barley. Under careful cultivation it should prove well adapted to grapes, almonds, and apricots.

Dungeness silt loam.—The soil to a depth of 15 inches consists of a gray silt loam of compact structure. When dry the surface is almost white, owing partly to the lack of organic matter. The subsoil varies, but is most frequently a compact, gray, or yellowish-gray silty clay loam or silty clay, usually mottled with reddish-brown iron stains. If plowed in the proper moisture condition the soil breaks up loose and mellow, but the high silt and clay content renders it quits sticky when wet. The surface is uniformly level and the moisture-retaining capacity good. In some cases the water table is so near the surface as to give the effect of subirrigation. The greater part of the type is covered with a heavy stand of fir, cedar, spruce, and pine. It is well adapted to oats, clover, alfalfa, grasses, truck, and berries of all kinds. Oat hay yields from 3 to 5 tons per acre and alfalfa and other hay crops from 2½ to 4 tons per acre.

Hanford silt loam.—The type is a brown, gray, or buff fine smooth silt loam, often micaceous, free from gravel, and underlain by a dark-colored silty clay loam or by light river sands. It is sticky when wet and has a compact structure, but is friable and easily cultivated when in proper moisture condition. The type consists of recent or present sediments formed along river flood plains and delta plains, is frequently subject to overflow, and is sometimes poorly drained and filled with alkali. It frequently supports a dense growth of willows or small timber. Fruits, potatoes, beans, sugar beets, asparagus, hops, alfalfa, and general farm crops can be grown when protected from overflow and the land properly drained.

Oxnard silt loam.—The soil is a brown compact sticky silt loam, 6 feet or more in depth, inclined to puddle and bake, but friable under cultivation. The material consists of the lower stream sediments drained from sandstone areas. It is usually rich in organic matter and occupies nearly level or slightly undulating flood and delta plains. Drainage is often poorly established, the subsoil heavy and impervious. Where well drained and favorably situated the type is devoted to lima beans, corn, and barley without irrigation, and to lima beans, walnuts, and fruits under irrigation.

Stockton silt loam.—The type is a smooth, micaceous, light-brown silt loam 6 feet or more in depth, of fine texture and rather compact, but friable under cultivation. It rests over a light-colored calcareous clay hardpan. The material is derived from recent stream sediments. The type occupies nearly level valley plains and slopes and in places supports a light forest growth. Drainage is fairly well established except in a few small low-lying areas. This is an excellent soil for fruits, vines, grains, and general farming.

Yolo silt loam.—The type is subject to considerable variation in texture, but where typically developed consists of 3 feet or more of light-brown heavy silt loam underlain by a brown silty clay. Strata of fine sand or silt sometimes occur in the deeper subsoil. The soil is generally friable under cultivation, but if worked when wet has a tendency to puddle. It consists of alluvial deposits from intermittent streams. The topography is level to gently sloping and the natural drainage is good. A growth of cottonwood and willow is found along the streams. When irrigated the type is adapted to a wide range of crops, including fruits, grain, alfalfa, sugar beets, and vegetables. It is at present devoted principally to dry-farmed grain.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Hanford silt loam	California 9, 20, 22	58,929
Stockton silt loam	California 23	16,512
Yolo silt loam	California 25	13,504
Oxnard silt loam	California 24	5,320
Dungeness silt loam	Washington 5	3,840
Arbuckle silt loam	California 25	1,600
Total		99,705

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

Silty clay loams in this province have been mapped in two localities, one occurring in the subhumid districts of southern Oregon, the other under somewhat more arid conditions in the interior valley of California. The silty clay loam soils are finer in texture and closer and more compact in structure than the silt loams, and have a greater water-holding capacity. They are, as a rule, more readily puddled and require more frequent and thorough tillage to maintain a good tilth.

Under favorable local conditions of climate, drainage, and irrigation, the clay loams are adapted to general farm crops, alfalfa, and to late pears, vegetables, and sugar beets. In adaptation to crops they hold a position intermediate between the silt loam and the clay loam groups. They are not of extensive occurrence and are at present used mainly for pasture and dry farming to grains.

Meyer silty clay loam.—The soil is usually 12 to 30 inches deep and underlain by yellowish-brown clay loam, silty clay loam, or by a substratum of sandstone and shale. The type is practically treeless and moderately to steeply

sloping. Drainage is fairly well established and the soil retentive of moisture. The more shallow areas are best adapted to grain production or to grazing. Where of sufficient depth the type is well adapted to pears and small fruits.

Willows silty clay loam.—This soil varies in color from a light ashy gray when dry to a dark brown or nearly black when wet. It consists of a sticky, compact silty loam from 15 inches to 6 feet or more in depth, underlain by a heavy, compact, reddish-brown or brown adobelike clay loam. During the dry season the surface often becomes baked and checked. It occupies small depressions in valley plains and is generally devoted to dry farming or to grazing. When drained and carefully irrigated it should be well adapted to alfalfa, sugar beets, or to other root and forage crops.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Willows silty clay loam	California 2	24,896
Meyer silty clay loam	Oregon 4	2,240
Total		27,136

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The clay loam soils derived from the alluvial fan and recent valley filling material occur most extensively in the northern half of the interior valley of California. Important but less extensive areas have been mapped in the southern half of the Great Interior Valley, in the local coastal valleys, and in the more arid districts of southern California.

The soils of this group are often poorly drained and, owing to heavy texture and impervious or compact structure, are usually readily puddled; they bake upon subsequent exposure to hot, dry weather, and are difficultly maintained in good tilth. When puddled they lose moisture quickly, although of marked water-holding capacity. Under favorable conditions of drainage and with intelligent management and thorough cultivation they are retentive of moisture and well adapted to agriculture without irrigation. When irrigated they require but a moderate amount of water. In dry-farming districts they are best suited to crops that cover the entire surface or to crops that permit frequent intertillage throughout the period of their growth.

In the poorly drained and nonirrigated districts they are generally devoted to grazing or dry-farmed grains. Under present conditions much of the area of the group is only suitable for such purposes. Where capable of irrigation, grains produce heavier and the yields are more certain. Alfalfa then becomes a profitable crop and dairying and stock raising with the production of forage crops a leading industry. Sugar beets can also be profitably grown under irrigation upon the better drained areas; grapes mainly for wines can be grown without irrigation. The soils of the group are too heavy for deciduous tree fruit culture, except in local areas of the more friable character, where almonds, late peaches, apricots, plums, prunes, and figs are grown to some extent, mainly for drying purposes. In southern California lima beans, nuts, and citrus fruits are successfully grown upon a relatively small acreage.

This group of soils requires heavy farm machinery. It should be considered a suitable soil for the commercial development of fruit or truck growing only under unusually favorable local conditions.

Arbuckle clay loam.—The soil consists of a brown clay loam carrying small amounts of gravel, grading at 3 feet into a lighter color, the deeper subsoil being a yellowish brown, compact clay loam or clay. The topography varies from flat to gently sloping with good natural drainage, except upon some of the lower flat areas, where artificial drainage is sometimes necessary. The soil is formed by the deposition of the finer material carried by foothill streams modified by more recent material washed from adjacent types occupying a more elevated position. Alkali occurs in harmful amounts in some of the poorly drained areas, but the soil is usually productive. Wheat and barley are the principal crops. Tree fruits and grapes are grown to some extent, and with

irrigation the type is adapted to general farm crops, alfalfa, fruit, and dairy farming.

Capay clay loam.—The type consists of a gray to brown, friable clay loam, in places extending to a depth of 6 feet, and sometimes carrying a small amount of fine gravel in the surface foot. The normal color of the subsoil is similar to that of the soil. Upon lower slopes the subsoil below 30 inches usually consists of a heavy reddish-brown clay. The type is of recent alluvial origin and occurs along intermittent streams. It is well drained and free from alkali. Grain crops, almonds, and grapes are successfully grown.

Dublin clay loam.—The soil is a very dark brown to black light-textured clay loam or heavy silty clay loam with more or less angular gravel. It is underlain at 1 to 2 feet by light-brown silty loam or light clay loam of silty character, becoming lighter in color and texture with increasing depth, usually grading into a loam at 4½ to 5 feet. It occurs along lower hill slopes and is well drained and retentive of moisture. It is treeless except for an occasional valley oak. The type is mainly dry farmed to hay and grain with good yields. Peaches, apricots, and prunes are grown to a limited extent, but the rainfall is too limited to insure certain crops without irrigation.

Esparto clay loam.—The type consists of a light brown clay loam with an average depth of 3 feet, underlain by a silty clay loam or clay loam, generally slightly heavier than the surface soil and lighter in color, which grades into a compact clay at a depth of 6 feet or more. It occupies slightly elevated ridges of comparatively level topography but with sufficient slope to insure good natural drainage and to render the land well suited to irrigation. The soil is friable and easily maintained in a good condition of tilth, while the heavy subsoil conserves moisture. The type is well adapted to grain crops, both wheat and barley giving good yields. Alfalfa and fruits, including apricots, peaches, figs, and almonds, are grown to some extent. Grapes have also been grown with good success.

Hanford clay loam.—The soil consists of a fine, smooth, and moderately porous buff or gray to dark-brown micaceous clay loam, from 2 to 6 feet deep. It is underlain by fine sand or fine sandy loam stratified in places with fine, stream-deposited sediments. The soil is usually friable, but is very sticky when wet and easily puddled. The type is composed of recent stream sediments and covers low, level areas over stream, flood, and delta plains. The soil in places contains alkali and is poorly drained. It is rich in organic matter. Where properly drained it proves a highly productive soil.

Modesto clay loam.—The type consists of a compact, dark-gray to nearly black, fine silty clay loam from 2 to 6 feet or more in depth, grading into light brown below 18 inches. It is of rather sticky character and somewhat susceptible to puddling. It grades imperceptibly into the Hanford clay loam. A bluish-gray alkali hardpan similar to that underlying the Fresno series may be encountered at any depth below 18 inches. The type occurs as elongated bodies lying parallel to the larger streams and occasionally subject to overflow. The surface is of slightly uneven character and marked by frequent sloughs and water courses, drainage being generally somewhat deficient. The type frequently carries excessive amounts of alkali salts and is devoted mainly to grazing. Areas of limited extent in which drainage and hardpan conditions are somewhat better than the average of the type are suited to the production of alfalfa and possibly of fruits.

Oxnard clay loam.—The type consists of a fairly compact, tenacious brown to nearly black clay loam, frequently gravelly and underlain at depths ranging from 2 to 4 feet by a compact and heavier phase of the same material. Under cultivation the surface soil is moderately friable. The type is derived mainly from sandstone and shale materials and occupies delta and alluvial fan plains, or more elevated sloping or undulating alluvial plains. Some colluvial material is mixed with the alluvium. It is rich in organic matter, is sometimes poorly drained, and occasionally contains alkali. Under favorable conditions it is adapted to barley, sugar beets, fruits, and vegetables.

Placentia clay loam.—The soil is a compact, plastic, reddish-brown clay loam, 6 feet or more in depth, puddling readily when wet and baking when dry. The subsoil is red. The type consists of the finer material washed from higher surrounding soil types and occupies small areas in local depressions or lower valley slopes. It is sometimes poorly drained and contains alkali, but is otherwise adapted to the same crops as the Placentia fine sandy loam.

Stockton clay loam.—The soil is light brown, smooth, and silty in texture, and from 18 to 24 inches deep. It is sticky when wet, puddling readily and

cracking to a moderate extent upon exposure to dry weather, but friable and easily cultivated under favorable field conditions. It is underlain by a subsoil of adobe structure and at a depth of 4 to 5 feet by light-yellow, silty, fine sandy loam. The type is free from alkali and the hardpan is often found at considerable depth. It occupies smooth, gently sloping, easily cultivated flood plains. It is devoted principally to dry-farmed grain crops, but is believed to be well adapted to grapes, peaches, prunes, figs, and, under irrigation, to alfalfa, berries, and truck crops.

Willows clay loam.—The soil consists of 3 to 6 or more feet of a heavy clay loam of light chocolate-brown color and of compact structure, baking and checking somewhat during the dry season. Where less than 6 feet in depth it is underlain by a reddish-brown, heavy, compact clay. The type occupies flats or drainage depressions of valley plains. The more elevated and better drained bodies are productive and usually dry farmed to grains. Under proper cultivation, irrigation, and drainage the type is well adapted to the production of alfalfa, grains, sugar beets, forage crops, and in favorably situated locations to grapes.

Yolo clay loam.—The type consists of a light-brown or chocolate-brown compact clay loam, often becoming lighter in color and heavier in texture with depth until at 3 feet it has the texture of a heavy clay loam or clay. The surface is flat or gently undulating, and the natural drainage of the type as a whole is good. Artificial drainage would in some cases increase the value of the more level areas. The type is an important fruit and alfalfa soil, the larger yields being obtained under irrigation. The chief crops grown are barley, wheat, and hay. The better drained areas are also adapted to wine and raisin grapes.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Willows clay loam	California 2, 25	68,928
Hanford clay loam	California 1, 10, 11, 19	31,976
Yolo clay loam	California 15, 25	31,296
Oxnard clay loam	California 9, 21, 24	30,574
Arbuckle clay loam	California 25	21,682
Modesto clay loam	California 11	13,824
Esparto clay loam	California 25	8,832
Stockton clay loam	California 13	8,512
Placentia clay loam	California 19	2,816
Capay clay loam	California 25	1,600
Dublin clay loam	California 8	1,344
Total		221,334

[1] For key to numbers in this column see p. 733.

GRAVELLY CLAY LOAM PHASE.

The gravelly clay loams of this province have been recognized in but one locality and are represented by a single soil type. Owing to the content of gravel the structure is more porous than that of the normal clay loam group. It is more readily permeated by moisture, more easily maintained in a favorable condition of tilth, is better drained, and requires a somewhat less heavy farm equipment in draft stock and machinery. While adapted to a rather light type of general farming, it is suitable, under favorable local conditions, to the production of pears, apples, and other fruits, and vegetables.

Medford gravelly clay loam.—The soil is dark to almost black, sticky and compact, and from 18 to 24 inches deep. It is underlain by a light-brown to dark-brown heavy clay loam or clay. The dark-colored soil material may extend to a depth of 6 or more feet with but little change in color or texture. Considerable water-worn to subangular gravel is associated with the type. Its physiographic features usually favor irrigation. Drainage is sometimes poorly developed. The type comprises gently sloping valley floors and represents old flood-plain deposits. It is traversed by minor stream courses, but is not subject to overflow or erosion. It is adapted to pears, apples, small fruits, grains, and alfalfa.

Area and distribution of the gravelly clay loam.

Soil name.	State or area.[1]	Acres.
Medford gravelly clay loam	Oregon 4	6,400

[1] For key to number in this column see p. 733.

CLAY LOAM ADOBE PHASE.

The clay loam adobe soils of this province are of widespread occurrence throughout the semiarid portion of the Pacific coast region.

The soil is normally of compact, tough, and relatively impervious character. Over poorly drained areas it is cold, wet, and late, percolation and subdrainage taking place very slowly. It is readily puddled and upon subsequent exposure during hot, dry periods bakes and checks to a pronounced degree. The checking, however, is frequently carried so far as to develop a loose surface condition, which arrests loss of moisture by evaporation. The soil has an exceedingly high water-holding capacity, and while of more compact character and more readily puddled than the soils of the clay loam class is more easily maintained in the granular condition favorable to good tillage and the retention of moisture. It requires a heavy farming equipment, deep plowing, and careful management.

The adaptation of the clay loam adobe phase to crops depends predominantly on the soil structure. Where not maintained in a granular structure by natural or cultural means the soil loses moisture quickly and is of exceeding refractory character. Under favorable conditions it is better adapted to general farm crops than the soils of the clay loam group, and under favorable local conditions of drainage and climate is widely utilized for the production of deciduous fruits and vegetables.

Where irrigated the clay loam adobes require but little water, and under intensive cultivation they are used successfully for the production of fruits or other cultivated crops without irrigation.

Some of the areas mapped are highly developed, wine grapes, sugar beets, small fruits, vegetables, pears, citrus fruits, and alfalfa being the principal products. The more extensively farmed areas are devoted mainly to the small grains and sugar beets.

Danville clay loam adobe.—The soil is a dark brown or black, light-textured clay loam from 24 to 36 inches deep, with varying quantities of angular fragments of shale or other rocks. It is underlain by a light-brown or slightly reddish brown loam or clay loam of somewhat lighter texture than the soil, frequently mottled with gray or yellow. The type is composed of alluvial stream outwash material from adjacent adobe hills spread over valley floors by intermittent streams. It is well drained and gently sloping. The soil is retentive of moisture. It is dry farmed to hay, grain, and fruit.

Dublin clay loam adobe.—The soil is a dark-brown to black, heavy-textured clay loam from 18 to 24 inches deep, carrying small fragments of shale and other rocks. When dry and cultivated the surface has a reddish-brown tint. The top soil is underlain by a compact clay loam slightly lighter in color and grading at depths of 4 to 5 feet into a yellowish-brown or yellow sandy clay loam or silty loam extending to a depth of 6 feet or more. The topography is slightly rolling with gentle slopes. The soil is well drained and friable under cultivation. It is dry farmed to grain and hay with fair yields.

Maricopa clay loam adobe.—The soil is a dark-gray, dark-brown, or nearly black adobe, generally of fine silty clay loam texture, sometimes carrying considerable fine gravel. It is from 30 inches to 6 feet or more in depth, and is usually underlain by a fine sandy loam or fine sand, and occasionally by coarse sand and gravel. The type occurs about the edge of foothills and extends into the bottom lands. It is derived largely from granitic material. It is retentive of moisture and adapted to grain crops and sugar beets. Where favorably situated, grapes, orchard fruits, and vegetables can be grown. This is an excellent loose, friable soil if irrigated and properly cultivated, but assumes a dense, compact, refractory structure if allowed to bake. It is generally free from alkali.

Oxnard clay loam adobe.—The type consists of a compact and plastic black or dark brown clay loam adobe, from 3 to 6 feet or more in depth, and underlain by heavy loam, sand, and sandy loam or disintegrating rock. It occurs

as alluvial, colluvial, or residual material, occupying level or sloping valley plains and rolling foothills. The material forming the soil is derived mainly from shales and crystalline rocks. The soil is difficult to till, but is retentive of moisture and productive. It is usually dry farmed to grains or is devoted to the production of fruits, sugar beets, or vegetables under irrigation.

Phoenix clay loam adobe.—The soil is of pronounced refractory adobe structure, becoming very sticky when wet and baking and checking upon subsequent exposure. Water-worn gravel is of frequent occurrence. The soil varies from 12 to 30 inches in depth. This layer is composed of stream outwash or alluvial-fan material derived from sandstone, shale, and to some extent from basalt. The deeper subsoil is residual from shale and sandstone. This soil is found in the Rogue River Valley, Oreg. It is adapted to pears, small fruits, and, when irrigated and of favorable depth, to alfalfa.

Placentia clay loam adobe.—The type consists of a reddish-brown or brown, compact adobe soil of clay loam texture, from 2 to 6 feet or more in depth, underlain by compact, heavy loam, coarse granitic sand, and fine angular gravel. Below the surface foot the color is often of a more pronounced red and the adobe structure more evident. The type consists mainly of alluvial-fan or alluvial-slope material derived from disintegrating granitic rock. It occurs upon rolling hills and sloping, elevated, and somewhat dissected valley plains, is well drained and free from alkali, and is usually dry farmed to grains or devoted to fruits under irrigation.

Portersville clay loam adobe.—The type is a heavy, dark-brown clay loam adobe, from 2 to 6 feet deep. At depths varying from 3 to 5 feet the subsoil becomes light brown in color and often contains a high lime content closely resembling marl or hardpan. Metamorphic rock fragments also occur throughout portions of the subsoil, and in places the surface soil closely approaches a stony loam adobe. This type is locally known as "dry bog." It is an excellent citrus fruit soil, some of the best orchards in the area being found on this type.

Stockton clay loam adobe.—The soil is a black, heavy clay loam of fine silty texture and of exceedingly stiff, dense, adobe structure. It is usually about 3 feet in depth and underlain by a light-brown or yellowish silty clay loam frequently separated from the overlying soil by a thin layer of white calcareous clay hardpan free from alkali. The soil puddles readily and bakes and checks upon exposure when not cultivated under proper moisture conditions. It is exceedingly sticky and of a stiff, waxy consistency when wet. The soil contains a large quantity of organic matter and under proper cultivation is capable of absorbing and retaining a large supply of moisture throughout long periods of drought. The type is composed of old alluvium sediments modified by weathering and the addition of organic matter. It occupies extensive areas of the lower valley plains and is either treeless or else supports occasional groves of valley oak and light timber. The surface is nearly level and drainage somewhat restricted. The soil is moderately friable and produces excellent yields of grain, hay, and general farm crops under careful cultivation.

Sutter clay loam adobe.—The type consists of a chocolate-brown clay loam with pronounced adobe characteristics, often carrying a surface mantle of 2 or 3 inches of a grayish-brown loam. Drainage is good. Grain for hay is the chief crop. The location insures protection from injurious frosts, and where water can be secured for irrigation the soil can be used for citrus fruits.

Area and distribution of the clay loam adobes.

Soil name.	State or area.[1]	Acres.
Oxnard clay loam adobe	California 9, 19, 20, 24	76,580
Maricopa clay loam adobe	California 3, 4, 19, 21, 22	73,316
Stockton clay loam adobe	California 23	53,312
Portersville clay loam adobe	California 15	32,832
Placentia clay loam adobe	California 9, 24	8,916
Sutter clay loam adobe	California 12	1,600
Dublin clay loam adobe	California 8	1,152
Phoenix clay loam adobe	Oregon 4	576
Danville clay loam adobe	California 8	256
Total		248,540

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The clays of this province so far as mapped are confined to broad areas of the Sacramento Valley in California.

They are usually of heavy, compact structure and some of the types are poorly drained and carry excessive quantities of alkali salts. Such areas are at present devoted mainly to pasture, although portions in which the alkali content is insufficient to cause injury or is confined to the subsoils are used for the shallow-rooted grain crops. Irrigation has been developed only to a small extent, as much of the poorly drained or alkaline areas can be reclaimed only by the expenditure of large sums of money.

Better-drained districts are utilized mainly for pasture or for the production of grains without irrigation, though grapes and alfalfa can be grown in favorable locations. When the land is well prepared, with thorough cultivation and irrigation, it may be used for alfalfa and ensilage crops, in connection with dairying and stock raising. Sugar beets may also be grown on a commercial scale, but at a cost of somewhat greater effort than upon the soils of lighter texture.

The clay group as a unit is too heavy and compact in structure to be adapted to the production of fruits or vegetables, except for local or home use. It is best adapted to heavy farming, dairying, and stock raising, and is most economically utilized in tracts of moderate size, improved where necessary by artificial drainage, and farmed with machinery and draft stock of heavy character.

Capay clay.—The type is a gray to grayish-brown heavy tenacious clay, about 3 feet deep, sometimes tinged with red, and underlain by a heavy reddish-brown or yellowish-brown clay. The surface is sometimes covered with a very shallow deposit of light loamy character. The type is usually of refractory nature, plastic when wet, and readily puddled. Occasional sloughs and creeks which have cut deep channels and built up low ridges along their banks by the deposition of material at times of floods break the surface. The level topography causes the natural drainage to be poor, and alkali is occasionally found in both soil and subsoil in sufficient quantities to be harmful to crops. The type is used mainly for the production of such crops as grain and hay. Favorably situated bodies are adapted to alfalfa and forage crops under irrigation.

Dunnigan clay.—This type consists of a sticky gray to black clay about 3 feet deep underlain by a light-brown to brown clay. The soil is inclined to puddle, assuming a yellowish or grayish to white color on drying into a hard crust. The topography is comparatively level, the surface being slightly uneven, owing to the presence of "hog wallow" depressions. Areas of this soil occupy a position between lower overflow basins and upper valley slopes and are subject to inundation at times of flood. The soil is formed of finer material derived from shales and sandstones deposited from flood waters and modified by alluvial wash from adjacent higher slopes. Alkali is usually present in injurious amounts. The type is used only for pasture. Not only does the land require artificial drainage, but it will be necessary to protect it from overflow by the construction of dikes.

Esparto clay.—The soil is a light-brown to dark-brown clay from 2 to 3 feet deep undelain by a light-brown clay or clay loam, becoming lighter in texture at a depth of 4 feet and grading at 6 feet into a silty clay loam or silt loam. The topography varies from flat on the lower levels to sloping along streams and at the base of the foothills.

The natural drainage is fairly good. The type is extensively devoted to the production of dry-farmed grain, barley being the principal crop. Alfalfa is grown on a small area under irrigation. Much of the type can be irrigated and devoted to the production of alfalfa, sugar beets, forage crops, and general farm crops. Fruits, including peaches, apricots, almonds, figs, and grapes, are grown to a small extent.

Sutter clay.—The type consists of a few inches of brown clay loam, underlain by a heavy silty clay, brown in the upper section and grading to a yellowish color in the subsoil. The surface has a uniformly good slope and is traversed by occasional stream washes. Some grain is grown, but except in seasons of heavy rainfall it is cut for hay. Alfalfa would probably succeed on well-drained areas and some varieties of grapes can be grown, except on the highest elevations.

Willows clay.—The soil varies considerably in texture, color, depth, and structure, merging gradually into the surrounding types. The soil consists of

a reddish-brown, compact, impervious, tenacious clay of adobelike structure, about 6 feet deep. The soil section is often marked at this depth by calcareous concretions or by a thin stratum of calcareous-clay hardpan. The type occurs as extensive, poorly drained, alkaline areas, barren of tree growth, occupying lower, nearly level valley plains. It is more or less subject to overflow during the rainy season and is generally devoted to grazing.

Yolo clay.—The type is a chocolate-brown clay 6 feet or more in depth, the subsoil becoming lighter in color and more silty in texture at a depth of 3 feet. When wet the soil is sticky and readily puddled. The topography is level to undulating. Drainage over the greater proportion of the type is good, although some of the lower lying areas where alkali is found would be improved by the use of tile or ditches. Wheat and barley are the principal crops grown. Alfalfa is successfully grown on this type.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Willows clay	California 2, 25	46,976
Capay clay	California 25	34,560
Yolo clay	do	29,888
Esparto clay	do	11,200
Dunnigan clay	do	8,576
Sutter clay	California 12	1,024
Total		132,224

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

The silty clay group in this province, so far as recognized, is represented by a single type confined to a single locality. Drainage is well developed and the type somewhat more friable and more readily maintained in good tilth than is the case with the clay member of the same series. The soil is as well or better adapted to heavy farm crops than the clays, and is more suitable for sorghum or other forage and root crops, including sugar beets. Late vegetables and table and wine grapes are also grown. A heavy farm equipment is required.

Yolo silty clay.—The type consists of 3 to 6 feet of smooth, silty chocolate-brown clay, easily handled and friable under cultivation. The topography is flat to gently undulating, with sufficient slope to insure good natural drainage. The type originally supported a heavy growth of oak and other timber. It ranks as an unusually productive soil, the principal crops being wheat and barley. Alfalfa is also grown to a limited extent. Fruit and grapes are grown successfully and the soil seems well adapted to beans, sorghum, sugar beets, Egyptian corn, and vegetables.

Area and distribution of the silty clay.

Soil name.	State or area.[1]	Acres.
Yolo silty clay	California 25	11,072

[1] For key to number in this column see p. 733.

SILTY CLAY ADOBE PHASE.

The silty clay adobe group is represented by a single type which has so far been mapped in one area of limited extent. Surface drainage and underdrainage are restricted and the type is utilized for grazing or the production of grains without irrigation. Where typically developed it should not differ essentially in crop adaptation or in equipment required from the silty clay soils.

Kirkwood silty clay adobe.—This type consists of a smooth dark-gray to nearly black silty clay of marked adobe structure sometimes approaching a heavy silty clay loam. It is inclined to puddle and crack and difficult to handle except under proper moisture conditions. The type occurs as extensive bodies, associated with soils of the Corning series occupying more elevated separations. The surface is level to gently sloping. For brief periods following

heavy rains, a water-logged condition frequently prevails, owing to inadequate underdrainage due to retarded percolation in the subsoils. The type is devoted to grain farming or grazing, with fairly good results. It is not adapted to fruits or other crops without irrigation, but would probably become suitable for the production of pears, alfalfa, and certain other farm crops and fruits under favorable drainage and irrigation conditions.

Area and distribution of the silty clay adobe.

Soil name.	State or area.[1]	Acres.
Kirkwood silty clay adobe	California 16	1,536

[1] For key to number in this column see p. 733.

CLAY ADOBE PHASE.

The clay adobe soils of this province are widely distributed throughout the semiarid regions of southern Oregon and the interior and coastal districts of California. They depart but little from the clay loam adobes in structural features, moisture-retaining capacity, and crop adaptation. They are, however, more frequently poorly drained and more highly impregnated with alkali salts. They are well adapted to general farm crops, but require the heaviest kind of farm equipment and careful management. A large proportion of the areas covered is, owing to poor drainage or to lack of irrigation facilities and to the usual well-developed moisture-retaining capacity of the soil, devoted to grazing or dry farmed to grains.

The clay adobe soils are, under favorable climatic, drainage, and cultural conditions suitable for the production of alfalfa, and citrus fruits, but are scarcely adapted to other fruit crops. Winter apples are grown to some extent in the Rogue River Valley, Oreg., but are less successful upon soils of such extremely heavy character than pears. Citrus fruits are very successfully grown in the Portersville district of California.

Capay clay adobe.—The type consists of a dark-brown or grayish-brown clay of adobe structure about 3 feet deep, underlain by light-brown, heavy clay often resting upon a stratum of coarse sand at a depth of 6 feet. The type occupies the lower, level valley plains and natural drainage is often deficient. Alkali is frequently present in sufficient amounts to be injurious to crops. The native vegetation consists of grasses, wild oats, and various alkali weeds. Grain is the principal crop, producing favorable yields in favorable seasons.

Coker clay adobe.—The type is of heavy, compact adobe structure, ranging in depth from 30 inches to 6 feet or more. It is sticky when wet, readily puddled, and checks upon exposure. Subangular to water-worn fragments of basaltic rock are occasionally found in the soil section. Drainage is generally fairly well established. In the Rogue River Valley, Oreg., the type, where not too shallow, is well adapted to pears.

Dublin clay adobe.—The soil is a dark slate colored to black, heavy clay loam from 12 to 15 inches deep, underlain by dark-brown to black, compact clay, grading at 3 to 5 feet to a yellowish or yellowish-gray compact clay loam, silty clay loam or coarse sandy loam with occasional pockets of gravel. The soil is less friable under cultivation than other adobe types occurring upon the hills. It occurs along upper valley slopes near the hills and over flats along minor hill streams. The greater proportion of the type is comparatively level to gently sloping. Drainage is sometimes deficient. It is of alluvial origin and formed by mixture of wash from the Diablo clay adobe with stream alluvium from the same source. A large portion of the type carries alkali salts, sometimes in excessive amounts. It is generally treeless and devoted to dry farming to hay and grain or to pasturage.

Medford clay adobe.—The soil is normally black, heavy, and tenacious, with an adobe structure. It usually extends to the depth of 6 or more feet with but little variation in color or texture. It occupies gentle slopes or nearly level areas. Drainage is poorly developed. In the Rogue River Valley, Oreg., it is devoted to apples, pears, and to alfalfa, but it is somewhat too heavy to be suited to apples.

Meyer clay adobe.—The soil is dark in color, ranges in depth from 6 inches to 6 feet or more, and is of adobe structure. The subsoil is yellowish brown and in local spots calcareous. With thorough culture areas of the deeper soil are well adapted to pears.

Norman clay adobe.—The type consists of a dark-brown or black tenacious clay adobe from 3 to 6 feet deep, which puddles when wet and cracks when dry, sometimes to a depth of 2 to 3 feet. It is underlain by a yellowish or bluish, mottled, rather impervious clay or clay loam. It occupies minor depressions of valley plains and sometimes is encountered in the foothills. Drainage is poorly established and the type is subject to overflow. It is alluvial in origin, the material being derived from sandstones and shales. Occasional accumulations of alkali occur. It is devoted to grazing and dry farming and can be irrigated.

Phoenix clay adobe.—The type ranges in depth from 12 inches to 6 feet or more, often carries water-worn, basaltic gravel, and has a reddish tint, which becomes darker with depth. Rock outcrop is frequent. Drainage is ordinarily well established, except over low-lying areas. The soil represents stream-outwash material derived from shales and sandstones and to some extent from basalt, the deeper subsoil being residual in origin and from conglomerate rock. In the Rogue River Valley, Oreg., the type constitutes an important apple and pear soil, being better adapted to the latter fruit.

Portersville clay adobe.—The type consists of a heavy clay adobe, ranging in color from dark brown to black, and in depth from 4 to 6 feet. It is known locally as "dry bog" from its tendency to check and clod when dry. The dark-brown color is more pronounced near the borders of the clay loam adobe of the gravel series. This type occurs on the lower portions of the foothills below the Portersville clay loam adobe type. On account of its topography and heavy texture, portions of this type when planted to citrus trees often require artificial drainage, otherwise it is considered an excellent citrus soil. The unirrigated portions are dry farmed to grain.

Redwood clay adobe.—The soil is black and of compact, refractory adobe structure. It becomes very sticky when wet and bakes and checks upon exposure, but under favorable moisture and cultural conditions is of moderately friable character. The subsoil is of black to dark-gray or drab color. The type occurs upon low, flat plains adjacent to stream estuaries or salt-water tidal marshes. It is often poorly drained and subject to the occurrence of marine salts and alkali. Under favorable conditions of climate, moisture, and drainage it is well adapted to heavy vegetables, such as cabbage, onions, cauliflower, and to hay and grain crops, apples, pears, berries, and sugar beets.

Stockton clay adobe.—The soil consists of a chocolate-brown to nearly black heavy clay loam or clay adobe, similar to the Stockton clay loam adobe in depth, character of underlying material, structure, drainage, and other general features. It differs from the Stockton clay loam adobe in its somewhat lighter color and lower organic matter content. It is a productive soil.

Willows clay adobe.—This type consists of a dense, compact, dark chocolate brown clay of adobe structure, free from gravel and 6 feet or more in depth. The lower portion of the soil section is somewhat lighter in color and marked by calcareous concretions and semiporous concretions. The soil becomes very sticky when wet, puddles readily, and bakes upon exposure during droughts. It occurs as extensive areas covering treeless valley plains and is frequently poorly drained, subject to overflow, contains alkali, and is cultivated with difficulty. With artificial drainage and careful irrigation and cultivation grains, alfalfa, and forage crops can be grown.

Area and distribution of the clay adobes.

Soil name.	State or area.[1]	Acres.
Willows clay adobe	California 2, 25	141,184
Stockton clay adobe	California 12, 13, 23	82,688
Capay clay adobe	California 25	31,232
Redwood clay adobe	California 21	30,400
Dublin clay adobe	California 8	14,848
Portersville clay adobe	California 11, 15	9,856
Meyer clay adobe	Oregon 4	8,960
Coker clay adobe	do	6,528
Norman clay adobe	California 2	6,208
Phoenix clay adobe	Oregon 4	4,544
Medford clay adobe	do	768
Total		337,216

[1] For key to numbers in this column see p. 733.

RIVER FLOOD-PLAIN MATERIAL.

The soils of the River Flood Plain province have been derived from a great variety of materials transported and worked over by the large rivers and permanent streams, which, during high stages or flood seasons, assort and spread out the soil material in terraces or flood plains along their normal channels. The materials have thus been subjected for considerable time to river influences and the poorly established drainage of bottom lands, with the result that the soils have general characteristics and properties not possessed by other groups of soils.

The soils of this province occur under a wide range of climate, varying from extremely humid to arid. Some of the streams traversing the glaciated regions of the northwest are of exceptional character in that they are at the present time carrying and depositing sediment contributed by active glaciers, while in certain parts of California and Oregon large quantities of sediment are in times of flood contributed by the erosion products of hydraulic mining operations.

Some of the soils occupy gently sloping to undulating, well-drained terraces, situated above the present flood plain. Others are confined to the recent or present flood plains and are poorly drained or subject to overflow where not protected by levees.

In the humid areas the soils of the province are devoted mainly to grain and hay crops and more intensively to hops, potatoes, truck crops, berries, and tree fruits. Extensive areas are still uncleared and not yet utilized for agriculture. In the subhumid and arid districts they are quite extensively developed, except where subject to periodical overflow. Here they are devoted to alfalfa, small grains, sugar beets, and fruits and vegetables.

The soils of this province constitute the most important types of the trucking, asparagus, pear, prune, sugar beet, and other special industries of the Pacific coast.

DESCRIPTION OF THE SOIL SERIES.

Agate series.—The soils are of light-brown or reddish-brown to brown color with subsoils consisting predominantly of basaltic and siliceous pebbles and cobbles with the finer interstitial material ranging from gray or light-brown to brown color. This material may be indurated or partially consolidated and is generally separated from the soil by a thin layer of impervious, ferruginous hardpan. The series occupies comparatively level to sloping valley plains, frequently traversed by poorly drained intermittent stream courses, and is sparsely timbered or treeless. The surface varies from smooth to irregular and is marked by "hog-wallow" mounds and depressions. Gravel and bowlders occur throughout the type, sometimes in excessive amounts. The fragments consist mainly of basaltic rock, usually rounded, but include a large proportion of subangular fragments of agate and chert. The members of the series are derived from old alluvial deposits constituting remnants of an early valley filling. They are usually well drained, but owing to the impervious subsoil material lower lying areas may, under irrigation, require artificial drainage. They are often separated from lower adjacent alluvial soils by terraces. The surface topography is generally favorable to the distribution of irrigation water, and where the friable surface soil is not too shallow, the soils can be used for the production of irrigated crops.

Anderson series.—The series consists of reddish-gray or light-red alluvial soils occupying valley-terrace plains of recent date and the bottoms of intermittent stream valleys. They usually contain subangular to rounded gravel and are underlain at less than 6 feet by beds of stream gravel or in places by compact clay and clay loam. They often support a considerable growth of brush and timber. The surface varies from level to sloping with frequent terraces. Erosion has been active over many of the types. The soils are of porous structure and well drained, although the lower lying bodies are sometimes subject to overflow. The series is of alluvial origin. Where not too gravelly they are adapted to the production of peaches, grapes, pears, prunes, and small fruits. In so far as mapped they are relatively inextensive and of secondary agricultural importance.

Area and distribution of the soils of the Agate series.

Soil name.	State or area.[1]	Acres.
Agate gravelly sandy loam	Oregon 4	4,416
gravelly loam	do	24,704
Total		29,120

[1] For key to number in this column see p. 733.

Area and distribution of the soils of the Anderson series.

Soil name.	State or area.[1]	Acres.
Anderson fine sandy loam	California 17	3,520
gravelly loam	do	14,528
Total		18,048

[1] For key to number in this column see p. 733.

Antelope series.—In character of underlying gravelly material, the occurrence of hardpan, depth of soils, and location the members of this series are similar to the Agate soils. They are distinguished from the latter by the dark-brown to black color of the soil material and by their lower topographic position. The types usually occur in the vicinity of intermittent streams and have been modified by alluvial wash from more elevated soils, and by deficient drainage. The soil material is derived mainly from basaltic and andesitic rocks. The soils are fairly well drained and treeless. On account of the shallow soil and hardpan, they are not very productive.

Area and distribution of the soils of the Antelope series.

Soil name.	State or area.[1]	Acres.
Antelope clay	Oregon 4	1,792
clay adobe	do	2,423
Total		4,224

[1] For key to number in this column see p. 733.

Bear series.—The soils are reddish brown and underlain by darker-brown, sticky loam, resting upon a substratum of water-worn gravels and sands at a depth of 4 to 6 feet or more. The higher lying areas are well drained and free from overflow, but lower lying areas are subject to occasional inunduation during flood periods. The series occupies river flood plains. The surface is generally level and sometimes gullied. The material is similar in origin, topographic position, and mode of formation to that of the Sacramento series. The lower lying areas support a growth of native grasses. The soils are well adapted to alfalfa, grapes, stone fruits, truck crops, and hops.

Area and distribution of the soils of the Bear series.

Soil name.	State or area.[1]	Acres.
Bear gravelly sandy loam	California 17	8,384
loam	California 12	10,816
Total		19,200

[1] For key to numbers in this column see p. 733.

Camas series.—The soils are light brown to dark brown, the dark coloring being quite pronounced upon the surface over local areas, and contain numerous small iron pellets. The subsoils are light brown or brown to reddish brown, shallow, and underlain by stratified gravel and bowlders. The series occupies recent alluvial stream terraces of level to gently sloping or undulating topography and include alluvial fan material. Basaltic outcrops and angular fragments occur along the steeper terrace slopes. Drainage is well established and in places excessive. Both soil and subsoil usually contain variable quantities of gravel and bowlders, mainly quartzite and basalt. The soils support a light stand of fir, hemlock, and some cedar. Some of the types are fairly well adapted to the general farm crops.

Area and distribution of the soils of the Camas series.

Soil name.	State or area.[1]	Acres.
Camas gravelly sandy loam	Washington 7	2,048
stony gravelly loam	do	512
silt loam	do	10,496
Total		13,056

[1] For key to number in this column see p. 733.

Chehalis series.—The soils are of recent alluvial origin, occupying stream valleys traversing the humid regions of residual basaltic soils and those of the Hoaquiam, Melbourne, Copalis, and Montesano series. They vary from gray or drab to reddish brown, some of the heavier types containing very much organic matter and showing a dark-brown to black color. The heavier members are of compact structure. The subsoils vary from yellow, gray, or mottled to light brown, dark brown, or reddish brown to black in color, the heavier members being usually of compact structure. The soils of this series are derived from material eroded from the silty soils occupying the uplands and redeposited in the river valleys by flood waters. The lighter-textured soils occur near the main stream channels where the coarser material was laid down in the swifter currents, while the heavier clay or clay loam occupy the broad, shallow basins, farther back from the streams, or estuary deltas which remain in a flooded condition for long periods after each freshet. Most areas of these alluvial soils are at present subject to overflow at times of high water. The topography of these valleys is almost level, and sloughs or abandoned stream channels are frequent, but the greater proportion of the land has a sufficient elevation above the present stream level to insure good natural drainage. The Chehalis soils are very productive.

Area and distribution of the soils of the Chehalis series.

Soil name.	State or area.[1]	Acres.
Chehalis loam	Washington 5, 7	2,304
silty clay loam	do	151,296
clay loam	Washington 7	34,560
clay	Washington 5, 7	5,120
silty clay	do	54,528
Total		247,808

[1] For key to numbers in this column see p. 733.

Columbia series.—The soils range in color from gray to buff and are distinctly darker when wet; they are generally micaceous, free from gravel, and contain a large amount of organic matter. The subsoils are similar to the soil material, showing outcrops of yellow and brown and are underlain by a substratum of fine sandy material. The material is derived from the weathering of basic and acid igneous, metamorphic, and sedimentary rocks, much of which has been transported from great distances. The series occupies present or recent river flood plains and estuarine deltas. The soils are sometimes sub-

ject to overflow, and the lower depressions are poorly drained. The surface varies from level to irregular, and sloughs and lagoons are of frequent occurrence. The soils usually support a growth of cottonwood and willows in the vicinity of stream channels. Under varying climatic conditions they are adapted to a wide range of crops, including hay, grain, truck crops, hops, sugar beets, prunes, and other fruits.

Area and distribution of the soils of the Columbia series.

Soil name.	State or area.[1]	Acres.
Columbia sand	California 18	1,408
fine sand	California 12, 16, 25; Washington 7.	23,808
fine sandy loam	California 2, 16, 17	14,720
Total		39,936

[1] For key to numbers in this column see p. 733.

Coquille series.—The soils are light reddish brown or brown to dark bluish gray, and usually free from gravel. The heavier members often show a dark or black color when wet, due to accumulations of organic matter or underlying or imbedded strata of peat. They are underlain by subsoils of light-brown or reddish-brown to bluish-gray or drab color, ranging in texture from porous sandy material to impervious clays, the heavier material being frequently mottled with iron stains. The soils of this series occur as recent alluvial stream deposits, derived from shales and sandstones. They occupy flood plains of stream valleys, are usually timbered or covered with brush, and are frequently subjected to overflow. The heavier members are poorly drained and marked by the occurrence of swamp and marsh vegetation, including willows and rushes. Under favorable conditions of drainage and cultivation, they are adapted to the production of grains, hay crops, potatoes, berries, and small fruits, vegetables and leguminous crops. Tree fruits do better upon the adjacent upland soils.

Area and distribution of the soils of the Coquille series.

Soil name.	State or area.[1]	Acres.
Coquille sandy loam	Oregon 3	2,688
fine sandy loam	do	4,736
silt loam	do	26,816
silty clay loam	do	8,320
Total		42,560

[1] For key to number in this column see p. 733.

Doty series.—The soils are light brown or yellowish brown to reddish brown and carry rounded gravel and cobbles. The subsoils are of yellowish brown to reddish brown and underlain by a substratum of rounded bowlders and gravel, mainly of basaltic character and encountered at a depth of 3 to 6 feet. The series occupies level to undulating or sloping terraces bounded by steep terrace slopes. Drainage is well established and the soils are free from overflow. Like the Nasel series, they represent mainly alluvial deposits, but include locally some colluvial material, derived from the soils of the Olympic and Melbourne series. They differ essentially from the Nasel soils in the darker color of the top soil, a larger organic matter content, and in the predominantly coarser character of the substratum. The series is subject to humid climatic conditions and supports a forest growth, mainly of fir, hemlock, and cedar. The soils are adapted to oats, hay, potatoes, and dairying.

Area and distribution of the soil of the Doty series.

Soil name.	State or area.[1]	Acres.
Doty silty clay loam	Washington 7	20,992

[1] For key to number in this column see p. 733.

Eld series.—The soils are of reddish-brown to red color and of heavy silty texture with occasional iron concretions and gravel. They are usually friable under cultivation. The subsoil is of heavy compact character and silty texture and of reddish-brown to gray color with mottlings. The soils are alluvial in origin, the material of which they are formed having been derived from the residual soils of basaltic hills, in some cases influenced by material from surrounding soils. They occupy recent stream bottoms and lower terraces. The topography is level and drainage well established, though some areas would be improved by ditching or tiling. The soils are forested, and when cleared are adapted to hay and grain. Where well drained, potatoes, truck crops, and fruits can be grown.

Area and distribution of the soil of the Eld series.

Soil name.	State or area.[1]	Acres.
Eld silty clay loam	Washington 5	4,352

[1] For key to number in this column see p. 733.

Elder series.—The soils are dark gray, friable, and often carry considerable quantities of dark-colored, water-worn gravel. The subsoils are subject to considerable variation, but are usually of light texture, stratified, porous, and often gravelly. The soils represent recent alluvial material derived from metamorphic rocks occupying stream flood plains and lower terraces, traversing semiarid valleys. They are often subject to overflow, and in many places forested with oak, willow, and brush. The surface is level to slightly ridged or eroded and is frequently marked by sloughs or stream channels. The soils are often deficient in moisture-retaining capacity and subject to drought. The heavier members are well adapted to dry farming and, under irrigation, suited to the production of alfalfa, small fruits, vegetables, tree fruits, and certain types to sugar beets.

Area and distribution of the soils of the Elder series.

Soil name.	State or area.[1]	Acres.
Elder fine sand	California 2	1,856
gravelly fine sandy loam	California 16	832
silt loam	do	3,392
silty clay loam	do	1,600
Total		7,680

[1] For key to numbers in this column see p. 733.

Elma series.—The soils are characteristically of a light-brown to reddish-brown color, occupying level to very gently sloping alluvial stream terraces and valley slopes along small streams. The subsoil consists of light-brown or brown to reddish-brown material of porous to compact structure, frequently underlain by glacial gravels which occasionally appear at the surface. They are derived from fine material washed down from the adjacent upland occupied by the silty residual soils and deposited over areas originally covered with glacial gravels and worked somewhat by colluvial material. The soil is therefore alluvial and the substratum glacial. In some areas the finer material has been

laid down as a shallow alluvium covering the coarse gravelly deposits, while in other cases the silt, clay, and fine sand have become mixed with the glacial material, forming a soil which contains a large amount of small gravel and small rounded cobbles throughout the 3-foot section. The soils of this series as a whole have good natural drainage and are very productive. The original covering consists chiefly of fir, with some spruce, cedar, hemlock, and alder. Although sometimes inclined to drought, the soils are adapted to the production of tree fruits, potatoes, oats, and hay crops.

Area and distribution of the soils of the Elma series.

Soil name.	State or area.[1]	Acres.
Elma gravelly sandy loam	Washington 5	3,584
loam	do	3,840
Total		7,424

[1] For key to number in this column see p. 733.

Evans series.—The soils are of buff to light-brown color, micaceous, and underlain at a depth of 3 to 6 feet by water-worn, stratified material, consisting of sands and gravels. The series occupies stream bottoms and second bottoms or alluvial valley plains of recent formation and traversed by intermittent streams. The soils are of alluvial origin, derived mainly from greenstone and granitic material, usually by erosion of the Tolo, Siskiyou, and Barron soils, deposited as low, broad alluvial fan or as flood plain material by streams, often of intermittent character. They usually support a forest growth. Drainage is well established, but low-lying bodies are sometimes subject to periodical overflow.

Area and distribution of the soil of the Evans series.

Soil name.	State or area.[1]	Acres.
Evans fine sandy loam	Oregon 4	1,920

[1] For key to number in this column see p. 733.

Feather series.—The soils are of light reddish-brown to brown or dark-brown color, 6 or more feet in depth, with but little variation in character of material other than the frequent occurrence of pockets or thin strata of fine sand and fine sandy loam in the deeper portion of the soil section. The series occurs upon low, flat areas of recent or present river flood plains, the surface often being pitted or eroded and marked by sloughs or lagoons. Drainage is usually deficient, and the types are frequently subject to overflow where not protected by levees. The soils are of alluvial origin, some of the material, however, having been deposited from still waters in overflow basins. They occur under semiarid climatic conditions and in the vicinity of the streams are quite heavily eroded. Much of the area is utilized mainly for grazing, but where protected from overflow the soils are productive and adapted to a wide range of crops, including alfalfa, pears, small fruits, and truck crops.

Area and distribution of the soils of the Feather series.

Soil name.	State or area.[1]	Acres.
Feather loam	California 12	8,704
silt loam	do	3,584
Total		12,288

[1] For key to number in this column see p. 733.

Felida series.—The soils are of grayish-brown to dark-gray color, often becoming black when wet. They are free from gravel. The subsoils are compact, light brown, with gray mottlings, and underlain by a substratum of compact, stratified silt, clay, and fine sand, with occasional pockets of rounded gravel. The series occupies elevated eroded terraces, traversed by deep stream valleys, and is derived from basaltic and andesitic material. Drainage is good, except over occasional low areas, and the soils are productive. Tree fruits and general farm crops give moderate yields.

Area and distribution of the soil of the Felida series.

Soil name.	State or area.[1]	Acres.
Felida silt loam	Washington 7	61,696

[1] For key to number in this column see p. 733.

Gridley series.—The soils are reddish-brown, contain water-worn gravel, and where less than 6 feet deep are underlain by dark-brown, reddish-brown, or nearly black heavy compact subsoils, with intermittent occurrences of reddish to grayish calcareous iron hardpan. The hardpan is of less dense and impervious character than that underlying the subsoils of the San Joaquin series. The series occupies level to gently undulating valley plains, including shallow depressions without drainage, and was originally forested with various species of oak. The materials forming the soils consist principally of late Pleistocene sediments, modified by addition of recent stream alluvium. They are derived mainly from the more elevated soils of the San Joaquin series, but in part from wash from the foothill slopes. The heavier members of the series are poorly drained, and some of the types are at times subject to overflow. The series embraces some of the most highly prized soils of the region for the production of peaches, pears, apricots, prunes, and table wine, and raisin grapes. Extensive areas are, however, still undeveloped and devoted chiefly to grazing or to the production of grains.

Area and distribution of the soils of the Gridley series.

Soil name.	State or area.[1]	Acres.
Gridley sandy loam	California 12	5,120
loam	do	65,728
silty clay loam	do	13,184
Total		84,032

[1] For key to number in this column see p. 733.

Honcut series.—The soils are of light reddish brown color and are underlain by dark-red subsoils. Water-worn gravel is sometimes present in the vicinity of stream courses, but is not of general occurrence. The surface is slightly sloping and drainage is fairly well established. The soils are of alluvial origin, and occupy stream bottoms and recent flood plains or lower terraces. They are utilized mainly for pasture and hay crops, but are well adapted to the growing of truck crops, alfalfa, small fruits, and deciduous tree fruits, including figs.

Area and distribution of the soil of the Honcut series.

Soil name.	State or area.[1]	Acres.
Honcut loam	California 12	2,816

[1] For key to number in this column see p. 733.

Kelso series.—The soils are grayish-brown to reddish-brown, with light-brown to reddish-brown subsoils, often mottled with gray, and underlain by a substratum of stratified gray silt, clay, and sand, containing pockets of fine water-worn gravel. The series occurs as comparatively recent alluvial terraces, having an elevation of 40 feet or more above the present flood plains. The topography is level to gently undulating. The series is of alluvial origin, and formed of material washed from adjacent soils, in part glacial and in part residual from basalt, shale, and sandstone rocks. With the exception of few small depressions, the drainage is good. The soils are retentive of moisture. The forest growth consists of a heavy stand of fir, with a scattering of hemlock and cedar.

Area and distribution of the soil of the Kelso series.

Soil name.	State or area.[1]	Acres.
Kelso silty clay loam	Washington 7	14,080

[1] For key to number in this column see p. 733.

Lauren series.—The soils are reddish-brown to light or dark brown, the surface being strewn with soft iron pellets. The subsoils are of light-brown to brown color, sometimes slightly mottled, and underlain by a porous substratum of stratified sand and gravel. The series occupies elevated terraces lying above present stream valleys and probably of alluvial, though possibly of marine, origin. The material deposited in these terraces has been derived mainly from basaltic rocks. They have been subject to considerable erosion, the surface ranging from gently sloping to undulating or rolling, and are dissected by deep, narrow stream valleys. The soils of the series are well drained. They are deficient in power to retain moisture. They, however, occur under humid climatic conditions, and in their native condition support a growth of fir, hemlock, and cedar. The soils are generally productive and adapted to general farming, vegetables, and tree fruits, according to type.

Area and distribution of the soils of the Lauren series.

Soil name.	State or area.[1]	Acres.
Lauren sandy loam	Washington 7	22,016
gravelly coarse sandy loam	do	23,040
fine sandy loam	do	20,736
silt loam	do	2,048
Total		67,840

[1] For key to number in this column see p. 733.

Livermore series.—The soils range from a light-brown to dark-brown color, often assuming a reddish tinge. The subsoil is of the same color as the soil, but lighter in texture and gravelly in the lighter members. The deeper members have more compact subsoils. The surface is comparatively level, although interrupted by occasional terraces or by depressions of former stream channels. The soils occupy stream terraces, and are treeless except for a few valley oaks. They are devoted chiefly to hay, grain, and wine grapes, with small areas in fruit, alfalfa, and truck crops.

Area and distribution of the soils of the Marcuse series.

Soil name.	State or area.[1]	Acres.
Livermore gravelly sandy loam	California 8	9,600
fine sandy loam	do	448
silty fine sandy loam	do	832
loam	do	3,520
silt loam	California 21	31,104
clay loam	California 8	576
clay	do	2,432
Total		48,512

[1] For key to numbers in this column see p. 733.

Marcuse series.—The soils are of grayish or dark-gray color, usually from 2 to 3 feet in depth, and underlain by plastic reddish-brown subsoils. They occupy flat river flood plains, are poorly drained, and subject to annual overflow. Alkali salts are frequently present in injurious amounts and the land is generally utilized solely for grazing.

Area and distribution of the soil of the Marcuse series.

Soil name.	State or area.[1]	Acres.
Marcuse clay loam	California 12	14,592

[1] For key to number in this column see p. 733.

Marysville series.—The soils are of light-brown color, from 18 to 48 inches deep. They are underlain by reddish-brown, compact, sticky subsoils of heavy texture, which in turn are underlain by a mottled gray ferruginous hardpan. The hardpan is rarely encountered at a depth of less than 40 inches and may not occur within the 6-foot section. The series occupies low, nearly level, treeless valley plains of semiarid character and of deficient drainage. Where not protected by levees they are sometimes subject to overflow. Underdrainage is poorly developed. Where protected from overflow and drained these soils are adapted to alfalfa, grapes, and fruits.

Area and distribution of the soil of the Marysville series.

Soil name.	State or area.[1]	Acres.
Marysville silt loam	California 12	8,000

[1] For key to number in this column see p. 733.

Maywood series.—The soils are of gray or grayish-brown to yellowish-brown color and friable, although some of the types are inclined to become puddled under unfavorable drainage and moisture conditions. The lighter members are underlain by water-worn gravels at a depth of 18 inches to 6 feet or more. The heavier members rest upon a rather compact and heavy but friable subsoil, usually of yellowish or yellowish-brown color. The soils consist of reworked material derived from earlier sedimentary deposits forming high terraces in filled-in valleys. The soils occupy second bottoms and comparatively low terrace plains covering valley slopes, and are frequently marked by intermittent stream channels. The topography is gently sloping. This series is of more recent date of formation than the related Tehama series, which it resembles in certain features. Some of the members are occasionally subject to overflow by flood waters of intermittent streams, but are usually well drained and free from overflow. The soils are treeless or support a scattering growth of valley oak, or in the vicinity of stream channels of willow and cottonwood. The heavier members are retentive of moisture and well adapted to dry farming. Under irrigation the series is suitable for a wide variety of crops, including alfalfa, tree fruits, and small fruits.

Area and distribution of the soils of the Maywood series.

Soil name.	State or area.[1]	Acres.
Maywood gravelly sandy loam	California 16	2,048
fine sandy loam	do	1,536
loam	do	8,576
silt loam	do	2,368
silty clay loam	do	384
Total		14,912

[1] For key to number in this column see p. 733.

Merced series.—The soils are of dark-brown to dark-gray or drab color, with light brown, gray, or drab subsoils. Both soil and subsoil are somewhat micaceous. The series is of alluvial origin and derived mainly from granitic or related crystalline rocks. It occupies river flood plains and lower terraces, usually of flat surface. The soils are frequently poorly drained and subject to overflow during times of high water and often contain injurious amounts of alkali salts. Sloughs and remnants of former stream channels are of frequent occurrence. Where protected from overflow and drained the members of the series are adapted to grain, hay, and other general crops.

Area and distribution of the soil of the Merced series.

Soil name.	State or area.[1]	Acres.
Merced silty clay loam	California 13	21,696

[1] For key to number in this column see p. 733.

Mocho series.—The series consists of light-brown, dark-gray, grayish-brown, or drab friable and porous soils, frequently containing water-worn gravel and varying in depth from 1 to 6 feet. The subsoils are extremely variable and usually consist of alternating layers of gravels, sands, fine sands, silty fine sands, silts, and clays, the latter of a brown or black color. The surface is nearly level, although occasionally interrupted by abandoned stream channels. Drainage of the lighter types is excessive. Small amounts of alkali are sometimes present. The series comprises alluvial flood-plain and alluvial stream-valley terrace soils. They are largely treeless, except for a little oak, sycamore, and willow along the streams, and are used for pasturage or dry-farmed grain and hay. Small areas are used for truck, fruit, sugar beets, and hops.

Area and distribution of the soils of the Mocho series.

Soil name.	State or area.[1]	Acres.
Mocho sandy loam	California 8	2,048
fine sandy loam	do	512
gravelly fine sandy loam	do	3,136
loam	do	576
Total		6,272

[1] For key to number in this column see p. 733.

Nasel series.—The soils are dark brown to black and contain large amounts of organic matter. The subsoils are heavy, light brown to yellow and gray, often mottled, and underlain at depths of less than 6 feet by a compact substratum of gravel and bowlders, with some interstitial sandy material. In some types the subsoil is absent, the gravels immediately underlying the soil. The soils include some colluvial material and are derived mainly from the material of the Melbourne and Olympic series. The series occurs upon old terraces lying along streams traversing areas of Olympic and Melbourne soils. They lie from 10 to 40 feet above the valley bottoms and are above overflow. The surface is level to gently undulating, the terraces descending to adjacent

bottoms or lower terraces by steep slopes. Drainage is well established. The forest growth consists of fir, hemlock, cedar, and spruce. The soils are deficient in moisture-retaining capacity, and subject to drought during the summer season. Under favorable moisture conditions they are adapted to oats, hay, and forage crops, potatoes, small fruits, and vegetables.

Area and distribution of the soils of the Nasel series.

Soil name.	State or area.[1]	Acres.
Nasel gravelly clay loam	Washington 7	6,656
silty clay	do	15,872
Total		22,528

[1] For key to number in this column see p. 733.

Neal series.—The soils are light brown to black, from 1 to 3 feet deep, the material extending to 2 to 6 feet or more with but little change in character. They are usually underlain by yellowish to brown compact subsoils of heavy texture, resting upon gray to brown shales. The lighter colored subsoils may, however, be thin or wanting or may be replaced locally by water-worn gravels. The series occupies flood-plains and second bottoms of recent formation, crossed by small streams but seldom subject to overflow. The soil material is of alluvial origin and derived by erosion of greenstones, basaltic, granitic, shale, and sandstone rocks. The subsoils are in part residual from the underlying shales. The members of the series are timbered with cottonwood, willow, etc., and occur under subhumid climatic conditions.

Area and distribution of the soils of the Neal series.

Soil name.	State or area.[1]	Acres.
Neal fine sandy loam	Oregon 4	2,368
silty clay loam	do	1,984
clay adobe	do	1,280
Total		5,632

[1] For key to number in this column see p. 733.

Pajaro series.—The soils vary in color from light brown to gray, and in texture from sand to a clay loam adobe. They are alluvial in origin and consist mainly of material derived from shales and sandstones. The subsoils are light yellow to black. The lighter types occupy the valleys of small streams and the margins of larger streams, while the heavier types occur in the poorly drained sections usually near the hills bordering the valleys. The topography is level, the soil bodies occurring in long, narrow strips approximately parallel to the streams. The larger part of these soils is well suited for irrigation and they are adapted to a wide range of crops, including vegetables, fruits, alfalfa, garden seeds, and grains.

Area and distribution of the soils of the Pajaro series.

Soil name.	State or area.[1]	Acres.
Pajaro sand	California 14	320
sandy loam	do	3,840
fine sandy loam	do	2,048
loam	do	5,120
silt loam	do	1,088
clay loam adobe	do	4,800
silty clay	do	640
Total		17,856

[1] For key to number in this column see p. 733.

Puget series.—The soils are brown to grayish brown or drab and frequently mottled with iron stains. With the exception of the lighter members, they are of rather compact and tenacious structure, containing a large amount of organic matter and are usually friable under cultivation. The subsoils are light brown to drab or gray, marked with iron stains, and in the heavier members consist of compact deposits of silt and clay. This is underlain by a fine sandy substratum, which does not always appear within the depth of 3 feet. The series occupies flood-plains in the vicinity of estuaries or stream outlets. The soils are of alluvial origin and derived from glacial material. The lighter textured soils occur near the main stream channels where the coarse particles are laid down by the swifter currents. Farther back from the stream the coarser sandy deposits have been covered by a layer of fine silt laid down in the quieter waters, while in low depressions where flood water collects the silt and clay sediments are usually many feet deep and no coarse sandy material is found in the subsoil to a depth of 3 to 5 feet. The soils of the river valleys often support a growth of cedar and other trees. They are very productive and are classed among the very best soils of the Puget Sound region. Oats, forage and hay crops, truck crops, and fruits all do well.

Area and distribution of the soils of the Puget series.

Soil name.	State or area.[1]	Acres.
Puget fine sandy loam	Washington 4, 5, 7	128,704
silt loam	do	106,176
silty clay loam	Washington 5	1,280
silty clay	Washington 4, 5	83,968
Total		320,128

[1] For key to numbers in this column see p. 733.

Sacramento series.—The soils are dark gray, drab, or black, often contain large quantities of organic matter, and are 6 feet or more in depth. When the material is less than 6 feet in depth the subsoils are variable and consist of gravel, sand, or heavy compact silt, usually drab or brown in color. The series occupies stream bottoms and river flood plains often marked by sloughs and frequently subject to overflow where not protected by levees, sometimes forming extensive fresh-water "tule" marshes. The lighter members occupy the slightly higher elevations of natural stream-built levees. The surface varies from irregular to smooth. The material consists of recent alluvial flood-plain deposits from shifting stream currents or from slack flood waters transported for long distances, a large proportion of which in some cases consists of débris resulting from hydraulic mining. It is derived predominantly from altered sedimentary and eruptive rocks, including slates, schists, diabase, amphibolites, etc., and includes a large amount of material from granitic or other quartz-bearing rocks. Alkali salts are sometimes encountered, but the affected areas are small. The better drained types support a vigorous growth of valley oak, and, in the vicinity of stream courses, a dense growth of sycamore, cottonwood, willows, vines, briers, and shrubs. Where protected by levees the soils are productive and adapted to the intensive production of sugar beets, truck crops, beans, hops, potatoes, and alfalfa, and prunes, pears, and other fruits.

Area and distribution of the soils of the Sacramento series.

Soil name.	State or area.[1]	Acres.
Sacramento sand	California 13, 25	7,488
sandy loam	California 13	4,864
coarse sandy loam	do	26,304
fine sandy loam	California 12, 18, 25	35,776
loam	California 17	4,480
silt loam	California 2, 12, 13, 16, 17, 18, 25	177,920
silty clay loam	California 2, 16, 25; Washington 7	100,928
clay	California 12, 23, 25	212,928
silty clay	California 2, 25	32,576
clay adobe	California 25	29,952
Total		633,216

[1] For key to numbers in this column see page 733.

Salem series.—The soils are dark brown to black in color and underlain by compact, reddish-yellow subsoils or by sands and gravels. The series occurs upon level valley plains and stream bottoms as recent alluvial deposits, which are derived from basaltic rocks. Grains, fruits, truck crops, and hops are the principal crops. Some of the types are forested. The sois are well drained, but occasionally subject to overflow.

Area and distribution of the soils of the Salem series.

Soil name.	State or area.[1]	Acres.
Salem gravelly sandy loam	Oregon 4	3,904
fine sandy loam	Oregon 4, 5	6,912
gravelly loam	Oregon 5	13,120
silt loam	do	78,656
clay loam	Oregon 4	4,736
clay adobe	do	4,352
Total		111,680

[1] For key to numbers in this column see p. 733.

Salinas series.—The soils vary from light or dark gray to black, and from 30 inches to 6 feet or more in depth, sometimes carrying gravel from granites, schists, gneiss, and other rocks. The subsoils are of lighter gray color, compact and heavy, and usually underlain by a substratum of light-colored, porous sands or sandy loams. In certain areas the subsoil is wanting, the soil resting directly upon granitic rocks, while in other areas the heavy subsoils are underlain by stratified water-worn gravel. The soils occupy river terraces. Sugar beets and grains are extensively grown.

Area and distribution of the soils of the Salinas series.

Soil name.	State or area.[1]	Acres.
Salinas clay loam adobe	California 10	18,400
clay adobe	do	11,580
Total		29,980

[1] For key to number in this column see p. 733.

Sams series.—The soils are of light-brown to dark-brown color, free from granitic material, and of friable structure. The subsoils are similar to the soil in color, but of heavy texture and rather compact structure. The series occupies valley plains or second bottoms of sloping to undulating topography, traversed by small intermittent mountain streams. The soils are well drained, free from overflow, and usually timbered where not farmed. The soil material is of alluvial origin, and derived mainly from greenstone and sandstone, with some material from basalt. The members occur under conditions of a subhumid climate and are usually well adapted to irrigation.

Area and distribution of the soil of the Sams series.

Soil name.	State or area.[1]	Acres.
Sams loam	Oregon 4	4,672

[1] For key to number in this column see p. 733.

Santa Rita series.—The soils are gray to dark drab or nearly black, frequently containing pockets of fine sand and gravel, and underlain by dark gray, brown, or drab, heavy, silty subsoils. The series occupies comparatively level valley plains, traversed by intermittent streams, the surface being sometimes interrupted by low ridges and depressions which mark old stream courses.

The natural drainage in many cases is poor, and in order to secure the best results, ditch or tile drains are necessary. In much of the area of these soils alkali is found, the quantity in some places being sufficient to injure crops. The soils are of alluvial origin but have been modified considerably by swampy conditions. The materials forming the soils are calcareous shale and sandstone. The types are generally treeless and marked by swamp vegetation. They are utilized mainly for pasture or are dry farmed to hay, grain, hops, sugar beets, and fruit.

Area and distribution of the soils of the Santa Rita series.

Soil name.	State or area.[1]	Acres.
Santa Rita loam	California 8	832
silty clay loam	do	1,344
clay adobe	do	3,456
Total		5,632

[1] For key to number in this column see p. 733.

Sifton series.—The soils are dark brown to gray or black, frequently gravelly, and contain a high proportion of organic matter. The subsoil has a coarse, porous structure, and consists mainly of rounded, stratified gravels and cobbles, with but a limited amount of interstitial material. The series occupies old alluvial or marine elevated terraces bordering present river valleys. The surface is level to gently undulating and marked by low mounds and ridges. Drainage is excessive and the soils are subject to drought, although they appear to have at some time been modified by conditions of deficient drainage. The areas occupied by the series are sparsely timbered and locally known as prairies. The soils are devoted quite extensively to prunes.

Area and distribution of the soil of the Sifton series.

Soil name.	State or area.[1]	Acres.
Sifton gravelly sandy loam	Washington 7	11,520

[1] For key to number in this column see p. 733.

Tassajero series.—The soils are dark brown, slightly mottled with gray, and frequently assume a reddish tinge over cultivated areas. The subsoils are heavy, slightly lighter in color, and underlain at a depth of 4 to 5 feet by a dark-brown to nearly black, heavy, compact substratum. The surface is generally level or gently sloping, and the soils well drained, containing little or no alkali. The members of this series are composed of alluvial material derived from sandstone and shale material. They occupy narrow, intermittent stream valleys and have been deposited by stream waters. The series is practically treeless, except for an occasional valley oak. The soils are dry-farmed to hay and grain, with a few small tracts in fruit.

Area and distribution of the soil of the Tassajero series.

Soil name.	State or area.[1]	Acres.
Tassajero clay loam	California 8	832

[1] For key to number in this column see p. 733.

Tehama series.—The soils are of yellowish-brown or reddish-gray color, compact structure, and under efficient cultural methods fairly friable. The subsoils are of heavy, compact, and impervious structure, but without true hardpan such as occurs beneath the Redding soils, although underlain by a compact

substratum of sand, silt, clay, and gravel. They differ little in color from the soil. They represent old alluvial deposits occupying treeless plains, at present somewhat elevated above minor stream courses, and are marked by terraces and "hog wallows." Erosion has been moderately active. The series is usually well drained and devoted to dry farming to grains. Under irrigation the soils are adapted to alfalfa, truck crops, and fruits.

Area and distribution of the soils of the Tehama series.

Soil name.	State or area.[1]	Acres.
Tehama gravelly loam	California 16	4,032
silt loam	do	29,888
clay	do	1,536
Total		35,456

[1] For key to number in this column see p. 733.

Toutle series.—The soils are grayish brown, light brown, or light gray in color, some of the types containing small, iron-cemented pellets. The subsoils are of light-gray to light-brown color. The series consists of porous, stratified stream-terrace deposits, derived from glacial outwash material consisting principally of pumice, and of vesicular basaltic and andesitic fragments. The material has been deposited along stream courses, which formerly provided an outlet for the glacial waters or melting ice. The soils occupy valley terraces of level to undulating character, free from overflow, and are forested principally with fir, hemlock, and cedar. Drainage is well established and in the types of coarser texture is excessive.

Area and distribution of the soils of the Toutle series.

Soil name.	State or area.[1]	Acres.
Toutle gravelly coarse sand	Washington 7	10,240
very fine sand	do	1,280
coarse sandy loam	do	2,304
Total		13,824

[1] For key to number in this column see p. 733.

Vina series.—The soils are dark gray to chocolate brown in color, carrying andesitic gravel and bowlders and underlain in places at less than 6 feet by indurated and andesitic bowlders and gravel or occasionally by finer sedimentary material derived from volcanic tufaceous deposits. The soil consists of recent alluvial deposits occupying flood plains, the material being formed mainly by erosion of the Tuscan soils. The members of the series are sometimes subject to overflow and poorly drained. They often support a growth of native trees consisting of valley oak, willow, and cottonwood. Dry farming to grains is the principal form of agriculture, but where not too shallow most of the types are well adapted, with irrigation, to the production of alfalfa, grapes, tree and small fruits, and truck crops.

Area and distribution of the soils of the Vina series.

Soil name.	State or area.[1]	Acres.
Vina fine sandy loam	California 16	8,768
loam	do	5,440
clay loam	do	6,848
clay adobe	do	4,928
Total		25,984

[1] For key to number in this column see p. 733.

THE SOIL TYPES AND THEIR USE.

Sand Group.

The agencies active in the formation of the soils in most of the larger flood plains in this province are more favorable to the deposition of the finer sediments. The more extensive areas of the coarser material, consisting predominantly of the various grades of sand, are most commonly developed immediately along the stream courses, where they are subject to overflow. They are usually barren, nonagricultural, and in many places of wind-blown character. Such areas have been generally mapped as Riverwash. The better types of the sand group in the River Flood Plains province of the Pacific Coast region are thus confined to rather small areas. They occur along the recent flood plains of streams traversing the interior and coastal valleys in California.

The soils of the group are of loose, porous structure, are often wind-blown, where not protected by trees or other vegetation, deficient in organic-matter content, and of low moisture-retaining capacity. Lower lying areas are frequently subject to overflow where not protected by levees, but the soil is otherwise well drained. Except under favorable natural conditions of moisture supply, they require frequent irrigation. They are easily tilled, and where irrigated or of good moisture-retaining capacity and not subject to overflow, are adapted to early stone fruits, grapes, early small fruits, and truck crops.

Under irrigation a copious water supply is necessary, as much water is lost by seepage. Frequent cultivation is also necessary to conserve moisture.

Relatively small areas of the soil are successfully utilized for the production of early peaches, cherries, apricots, almonds, and table or raisin grapes. The yields of fruit or early vegetables are, however, lighter than upon the heavier textured soils, and are obtained at greater expense in cultivation and fertilization. This is offset to some degree by earliness of maturity.

The group requires light farming equipment, and is not adapted to general farming or to the heavier or later vegetables or fruits.

Columbia sand.—The soil consists of a light-gray to grayish-brown sand of loose porous structure. The subsoil is of similar color or slightly lighter than the surface material and differs but little from it in texture or structure. The deeper portions or substratum may be of porous gravel or occasionally of loam or silt loam. The type is of recent alluvial origin and occupies areas of stream bottoms or lower terraces of limited extent. The surface is in places barren of vegetation and wind-blown; in others the soil supports a heavy growth of forest trees, vines, and brush. It is derived from a wide variety of igneous, metamorphic, and sedimentary rocks. Lower lying areas are subject to overflow and the type is deficient in organic matter and in moisture-retaining capacity. Where protected from overflow and favored by climatic conditions or by facilities for irrigation, it is adapted to early truck, vine, and tree fruits. It is utilized mainly for the production of raisin or table grapes, peaches, cherries, and apricots.

Pajaro sand.—The type consists of a loose, incoherent, light-brown sand, 6 feet or more in depth, mixed with fine gravel and silt. It is derived mainly from sandstones and shales. The type is porous and is too dry for orchard purposes. The surface is level. Willows, weeds, and native grasses are the common vegetation.

Sacramento sand.—This is a loose, incoherent, medium to fine sand of light-gray to dark-gray color, extending to a depth of 2 to 6 feet or more. Where of less depth than 6 feet it is underlain by stratified sediments. It is usually associated with breaks in river levees or points at which flood waters leave the stream channels, and where accumulated is the first product of deposition. The surface is marked by mounds or ridges, and may be barren of vegetation or covered with a growth of young cottonwoods or willows. It is of little agricultural value and requires protection from overflow and leveling, in which case favorably situated bodies may in time be rendered capable of cultivation to intertilled truck crops.

Area and distribution of the sands.

Soil name.	State or area.[1]	Acres.
Sacramento sand	California 13, 25	7,488
Columbia sand	California 18	1,408
Pajaro sand	California 14	320
Total		9,216

[1] For key to numbers in this column see p. 733.

GRAVELLY COARSE SAND PHASE.

The gravelly coarse sand has in this province been encountered in one area and is represented by a single soil type covering a small area. It is of loose, porous, leachy structure, droughty, and except in the immediate surface deficient in organic matter. It has not been developed to any extent. Although occurring in a humid, heavily forested region, irrigation would probably be necessary to render crop yields certain or profitable, although the production of early truck crops may prove possible under intensive methods of cultivation.

Toutle gravelly coarse sand.—The soil is a gray to grayish-brown coarse sand of porous structure, 10 to 12 inches deep, containing a considerable amount of rounded pumice or andesitic and basaltic gravel. The soil is usually covered with 2 or 3 inches of organic matter, imparting a dark color to the surface. The subsoil is an ashy gray, coarse, incoherent sand, containing a larger quantity of glacial gravel, cobbles, and bowlders than the soil. Small quantities of white, silty rock flour often occur in the soil and subsoil. The type occupies low terraces with steep slopes and has a level to gently undulating topography. The natural drainage is thorough and sometimes excessive, and the type subject to drought. Below the immediate surface the organic matter content is low.

Area and distribution of the gravelly coarse sand.

Soil name.	State or area.[1]	Acres.
Toutle gravelly coarse sand	Washington 7	10,240

[1] For key to number in this column see p. 733.

FINE SAND GROUP.

The fine sands of the River Flood Plains and River Terraces, so far recognized, are confined to two soil series mapped extensively in the Columbia and Sacramento River valleys.

This group of soils, except where protected by levees, is usually subject to overflow. The soil usually occurs in the immediate vicinity of the stream channels and except in areas of recent deposition or where subject to destructive erosion, is usually covered with forest and often with a dense and tangled growth of vines and brush. Under such circumstances clearing is rather difficult and expensive and in regions of deficient rainfall considerable leveling is often required to prepare the land for irrigation. When cleared unprotected areas are sometimes locally subject to drifting.

In the more humid regions the soil is devoted to grazing and to hay crops, owing to long periods of overflow and wet condition during much of growing season. Vegetables are, however, successfully grown to some extent.

In the more southern areas occurring in the Interior Valley of California, the soil is utilized mainly for pasture, or dry-farmed to grains, although where protected from overflow it is well adapted to early vegetables, hops, and early stone fruits, small fruits, and early truck farming. Where of sufficient depth alfalfa may be profitably grown, although the heavier and more moist soils are better adapted to this purpose.

While not extensively developed, the members of this group constitute important soils for the intensive cultivation of truck and fruit crops. They are in this respect much superior to the soils of the sand group and can be efficiently utilized for such purposes in small tracts with the aid of a comparatively cheap and light farming equipment.

Columbia fine sand.—This type consists of a light, incoherent, yellowish-brown or buff fine sand varying in depth from 18 inches to several feet, underlain by a light-colored fine sand or sometimes by heavier deposits. The soil is usually subject to annual overflow and the texture is frequently altered by fresh accretions of silt or fine sand. The type is of alluvial origin, and areas not protected from overflow are annually increasing in extent through deposition of material during times of floods. The topography varies from nearly level to irregular or eroded. The older areas of this type support a growth of willows, cottonwood, and grasses, while those of more recent origin are devoid of vegetation, except where sand has been deposited around already established trees. Very little of the type is cultivated, owing to the liability of annual inundation. The agricultural value of the land depends upon levees. In some localities the soil is used for fruits, grapes, hay, and truck crops where not too deficient in organic matter, and under favorable climatic or irrigation conditions it is adapted to truck growing and to small fruits.

Elder fine sand.—The soil to a depth varying from 6 inches to 3 feet is a friable, dark-drab, micaceous fine sand, underlain by river sands and gravels to a depth of 6 feet or more. The surface is characterized by small ridges, mounds, and little pits. The type occurs as bottom lands, lying but little above the stream channels, and is subject to overflow and destructive erosion during times of floods. Underdrainage is good. The timber growth consists of massive oaks and willows. The type is devoted mainly to dry farming or pasture. If protected from overflow, the deeper areas are well adapted to alfalfa, vegetables, and some classes of fruit.

Area and distribution of the fine sands.

Soil name.	State or area.[1]	Acres.
Columbia fine sand	California 12, 16, 25; Washington 7	23,808
Elder fine sand	California 2	1,856
Total		25,664

[1] For key to numbers in this column see p. 733.

VERY FINE SAND PHASE.

Soils of very fine sand texture are somewhat unusual and are represented in the province by a single type. While the immediate surface is characterized by a large amount of organic material, the deeper soil and subsoil is of loose, porous character, deficient in organic matter and in moisture-retaining capacity. The type has not been developed extensively for agriculture and is of little importance. Although occurring under humid climatic conditions, irrigation would probably be necessary to the profitable use of the soil for farming. In the moister areas early vegetables, stone fruits, and small fruits can be grown to some extent under intensive cultivation.

Toutle very fine sand.—The soil consists of a gray to grayish-brown very fine sand, 8 to 12 inches deep, carrying sufficient organic matter in the surface 2 or 3 inches to impart a dark color and loamy texture. The subsoil consists of a light-gray fine sand, extending to a considerable depth and underlain by coarse, water-worn gravel. Both soil and subsoil are frequently marked by brown iron stains, and carry small iron-cemented pellets and some small gravel, consisting chiefly of pumice or very porous andesite and basalt. Small amounts of white material, resembling rock flour, are in many places seen throughout the 3-foot section. Where cuts occur in this type the material is seen to be distinctly stratified. The type occupies terraces lying 20 to 30 feet above the present stream channel, of level to undulating topography. Drainage is usually excessive, which, with the prevailing low organic-matter content below the immediate surface and the porous character of the soil, renders the type of low moisture-retaining capacity and subject to drought.

Area and distribution of the very fine sand.

Soil name.	State or area.[1]	Acres.
Toutle very fine sand	Washington 7	1,280

[1] For key to number in this column see p. 733.

SANDY LOAM GROUP.

The soils of the sandy loam group are widely distributed and occur under a number of soil series. They vary greatly in climatic environment, character of underlying material, drainage, irrigation, and power to retain moisture.

In the humid coastal districts of southwestern Oregon the sandy loams are of small extent. Only one series is represented, the soil occupying stream terraces or old flood plains, lying well above present stream channels. It is well drained, and owing to its porous structure and topographic position, is of low moisture-retaining power, making constant cultivation imperative during dry periods. It is devoted quite extensively to potatoes and, under favorable conditions, to strawberries, early truck crops, and bush fruits. Forage crops, particularly corn, kale, vetch, and cowpeas, do well. Tree fruits are not very successful.

In the Columbia River Valley in Washington another member of the group is found occupying old elevated terraces and underlain by a porous, gravelly, and sandy substratum. Drainage is often excessive. The type is utilized mainly for the production of forage crops, hay, fruits, and vegetables.

In the subhumid and semiarid coastal valleys of California small areas of sandy loams of two series have been recognized. Drainage is excessive in both cases and the soils are devoted to grains, hay, forage, truck, and fruit crops. In the Livermore Valley, lying some distance from the coast and entirely inclosed by the ridges of the Coast Range, the greater part of the type is utilized for grain production. It is too porous to be well adapted to this purpose and the growing of peas, early cabbage, potatoes, and other truck crops has proved more remunerative. These products are grown by intensive cultivation but without irrigation. In the Pajaro Valley, lying much nearer the coast, the sandy loam soils of the province have proven particularly well suited to the production of fall and winter apples, cherries, plums, prunes, pears, English walnuts, strawberries, brambleberries, cantaloupes, early tomatoes, cucumbers, etc. Alfalfa is also successfully grown.

In the interior valley of California the sandy loams, representing two important soil series, are generally well drained, although sometimes subject to overflow where not protected by levees. They are devoted to pasture, dry-farmed grains, and in part to the production of grapes, alfalfa, fruits, and vegetables. They are best suited to early peaches, table, wine, and raisin grapes, strawberries and brambleberries, apricots, melons, and early truck crops.

While suitable for the production of alfalfa and forage crops under irrigation or where favored by natural conditions, moisture supply, proximity to market, and good transportation, the soils of the group are more profitably employed in the production of intensively cultivated early vegetables, berries, stone fruits, grapes, potatoes, and, in local areas, early apples. While of low moisture-holding capacity they are friable and capable of sustaining a highly developed intensive system of agriculture, for which purpose they require only a moderate farm equipment.

Coquille sandy loam.—This type consists of a loose, porous sandy loam from 15 inches to 3 feet or more in depth and varying from reddish-brown to light brown. It is generally underlain at about 3 feet by loose sandy loam or sand, sometimes grading into heavy silt loam or clay. Some areas are covered by a shallow layer of sand. The type occurs upon the more elevated bottom lands well above the streams. It is thoroughly drained, but, owing to its open texture, somewhat droughty. It owes its origin to the deposition by flood waters of the coarser grades of sediment derived mainly from shale and sandstone. With frequent intensive cultivation to conserve soil moisture the type is well adapted to potatoes, berries and small fruits, vegetables, and leguminous crops.

Oridley sandy loam.—This type consists of a reddish-brown sandy loam, from 2½ to 6 feet deep, frequently containing fine water-worn gravel. Where the

sandy loam is less than 6 feet in depth it is underlain by dark-brown sticky loam. Occasionally a gray, calcareous hardpan is found at or below 4 feet. The surface is level to slightly rolling and the elevation is greater than that of surrounding soils. Drainage is good, although the type may be overflowed occasionally for a short time at periods of very high water. The original growth of oak has been largely removed and the soil devoted to pasture and grain, with some orchards and vineyards. It is an excellent peach soil and is adapted to grapes, alfalfa, and berries.

Lauren sandy loam.—The soil is of brown to reddish-brown color and has an average depth of 12 to 15 inches. The subsoil is a light-brown sandy loam which becomes lighter in color and slightly coarser in texture as the depth increases. At an average depth of 4 to 6 feet the subsoil grades into a compact, stratified, coarse loamy sand and fine gravel, which continues to a depth of many feet. The topography varies from level to gently rolling. Drainage is thorough and along the slopes often excessive. This type is well adapted to fruits, vegetables, hay, and forage crops.

Mocho sandy loam.—The soil is variable in character, but consists in general of a brown to grayish-brown, light-textured sandy loam. It sometimes consists principally of alternating strata of fine sand, silty fine sandy loam, or coarse sand. Gravel often occurs. Where less than 6 feet deep the soil is underlain by a dark-brown to black clay loam or clay at depths of 3 to 5 feet. The type is easily cultivated and of wide distribution, occurring as long, narrow strips along creeks or stream channels. It is alluvial in origin and still in process of formation. The surface is generally of gentle slope, but often broken by ridges and depressions representing abandoned stream channels. Drainage is rather excessive, except in low-lying heavy phases, which remain waterlogged during the wet season. Alkali in small amounts is sometimes present. A growth of sycamore, oaks, and willows occurs on some of the older bodies. The type is devoted to grazing or dry farmed to grain or hay, with limited areas devoted to fruits or truck crops.

Pajaro sandy loam.—The type consists of a dark-brown sandy loam 6 feet or more in depth, occasionally containing small gravel, sometimes accumulated in pockets in the subsoil. The dark surface soil extends to 30 inches, below which the subsoil becomes lighter in color and texture. The type is well drained, easily tilled, and retentive of moisture. It occurs principally in the long, narrow valleys of minor streams. It is light in color and texture near the mountains, becoming darker and heavier as the lower portion of the valley is approached. In the larger valleys it is usually found associated with other lighter soils of this series near the streams. This soil is well suited to berries, garden truck, and apples.

Sacramento sandy loam.—Where typically developed this soil consists of a gray to chocolate brown, smooth, micaceous sandy loam, often carrying a large amount of fine sand and 6 feet or more in depth. It may be underlain by coarser sands and gravel at less depth. Like other members of this series, the type is subject to much variation in color, depth, and texture. It occurs as elongated to moderately extensive bodies, the smaller tracts often being cut by sand ridges and marked by uneven topography. It is frequently subject to overflow, but where well drained and protected by levees it is well adapted to truck crops, berries, melons, and orchard fruits.

Area and distribution of the sandy loams.

Soil name.	State or area.[1]	Acres.
Lauren sandy loam	Washington 7	22,016
Gridley sandy loam	California 12	5,120
Sacramento sandy loam	California 13	4,864
Pajaro sandy loam	California 14	3,840
Coquille sandy loam	Oregon 3	2,688
Mocho sandy loam	California 8	2,048
Total		40,576

[1] For key to numbers in this column see p. 733.

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GRAVELLY COARSE SANDY LOAM PHASE.

Only one type of the gravelly coarse sandy loam phase has been recognized. This is found in the Columbia River Valley. Like the sandy loam of the same series, it occupies elevated river terraces and is underlain by a porous substratum of coarse texture. Owing to the coarser texture and more open structure of the soil material it is somewhat more droughty than the sandy loam. It is, however, friable, and with intensive cultivation is readily maintained in a state of tilth favoring the retention of moisture. Under irrigation it would require more water than the normal sandy loams and would be better adapted to extremely early fruit or truck crops. The range of crops which might be successfully grown upon it is narrower than in case of the soils without gravel. It is used for the production of prunes. It is also well adapted to cherries, early pears, and apples, small fruits, potatoes, and the lighter vegetables.

Lauren gravelly coarse sandy loam.—The soil is a light-brown to reddish-brown coarse sandy loam 12 inches deep, containing fine and coarse gravel. The subsoil consists of a coarse sandy loam also carrying a large amount of coarse gravel. The gravel content of both soil and subsoil varies considerably over areas of small extent. In some places it is so abundant that the entire subsoil to a depth of several feet consists of a compact mass of rounded gravel, while in adjacent areas both the soil and the subsoil are comparatively free of this material. The entire type is underlain at an average depth of 4 to 6 feet by a stratified deposit of coarse sands and gravel, often cross bedded. The coarse, porous character of the soil and subsoil causes the drainage of some of the areas occupying slopes to be excessive. It is quite extensively devoted to the production of prunes. Under intensive cultivation it is well adapted to pears, apples, cherries, small fruits, potatoes, and vegetables.

Area and distribution of the gravelly coarse sandy loam.

Soil name.	State or area.[1]	Acres.
Lauren gravelly coarse sandy loam	Washington 7	23,040

[1] For key to number in this column see p. 733.

GRAVELLY SANDY LOAM PHASE.

The gravelly sandy loams of the River Flood Plains and River Terraces have been encountered more frequently than the nongravelly sandy loams. The soil is in all cases underlain by a substratum of gravel or sand or by subsoils of coarse, porous character.

In the case of the Agate series the substratum is of cemented or indurated, impervious character. With this exception the underlying material of the gravelly sandy loams is porous and readily permeable to water. The soils are deficient in moisture-retaining capacity, are usually excessively drained, and where not favored by an abundant rainfall, give low yields, unless irrigation and intensive cultivation are practiced.

They are normally slightly less retentive of moisture than the members of the loam group and, when the water table lies at sufficient depth, are somewhat better adapted to fruits requiring thoroughly drained soils. They are rarely subject to overflow and generally occupy stream terraces lying well above present stream channels.

In the humid districts of western Washington the soils of this group occupy areas of limited extent, and only small portions of the area covered have as yet been converted into farms. Hay, potatoes, and small fruits, grown mainly for home use, are the principal products.

In the Columbia River Valley in Washington the gravelly sandy loams are adapted to prunes, early vegetables, and small fruits, which are successfully grown in the more favorable locations through the practice of intensive cultivation, though in the ultimate and more complete development of the soils irrigation will become necessary.

In southern Oregon gravelly loam types in two series have been recognized, one of which occupies stream bottoms and lower terraces, the other occurring upon the older and more elevated terraces. The former, where of sufficient depth

and favored by conditions of moisture, is suitable to the production of apples, pears, vegetables, and small fruits. It has not been developed extensively and is not of great agricultural importance. The higher lying type is underlain by an impervious hardpan substratum impenetrable to roots, is shallow, has a low moisture-retaining power, and is utilized mainly for grazing. Under irrigation it may prove suitable for the production of small fruits or shallow-rooted crops, and possibly, by blasting, to early stone or other tree fruits.

In the Interior Valley of California soils of gravelly sandy loam texture, representing two important series, are, when irrigated, excellently adapted to the production of alfalfa, early vegetables, fruits, and olives. The areas are, however, utilized mainly for grazing or for the production of dry-farmed grains, irrigation systems not having been installed to any extent. In the Livermore Valley in California one member of the group is extensively devoted to the culture of dry-wine grapes without irrigation.

The gravelly sandy loams are capable of being efficiently handled with light farming equipment and in small, intensively cultivated tracts.

Agate gravelly sandy loam.—The soil ranges in depth from a few inches to 2½ feet, usually containing small water-worn gravel, cobbles, or basaltic fragments. The organic-matter content is low and the surface is uneven and irregular. Portions of the type as mapped support a heavy growth of manzanita and ceanothus, with some pine and oak. Owing to the prevailing shallow character of the type it is best adapted to shallow-rooted crops.

Bear gravelly sandy loam.—This type consists of a light-brown to reddish-brown, open and porous light sandy loam carrying varying quantities of rounded or flattened gravel or cobbles, and underlain by beds of water-worn cobbles or gravels. It is often subject to overflow from adjacent streams. The type occurs as extensive bodies of uneven or eroded surface. Crops can be grown only under copious irrigation.

Elma gravelly sandy loam.—The soil consists of a reddish-brown, dark-brown, or nearly black gravelly sandy loam carrying considerable fine silty material and at times large amounts of organic matter. A few rounded glacial cobbles are strewn over the surface and distributed throughout the soil section. It is underlain by a brown or reddish-brown gravelly loam with a high percentage of rounded glacial rocks and coarse gravel. The soil is both glacial and alluvial in origin. The coarser material which makes up the greater portion of the subsoil, as well as a small part of the soil, represents glacial deposits, while the finer material is derived from later deposits of colluvial and alluvial material. The type is of limited extent, being found only along the minor streams. It is comparatively level, porous, and inclined to be excessively drained. Much of the type has been logged off, but only a small area is under cultivation. Where drainage is not excessive the type produces fair crops of hay, potatoes, and small fruit.

Camas gravelly sandy loam.—The soil to a depth of 6 to 12 inches is dark brown and contains a variable amount of rounded gravel, mica, and small bowlders. The subsoil, to a depth of 3 feet or more, is a light-brown or brown, imperfectly stratified sandy loam or loamy sand, which carries a much higher percentage of gravel than the soil. The soil material has been deposited by swift streams flowing at higher levels than at present. The surface soil has been modified to some extent by fine material from the adjacent uplands and by the accumulation of organic matter. The topography is level to gently undulating. Owing to its position and the porous character of the subsoil, drainage over the greater proportion of the type is excessive. The soil supports an inferior and stunted growth of fir. The type is deficient in moisture-retaining capacity and subject to drought, but where capable of irrigation is best adapted to fruit.

Livermore gravelly sandy loam.—This is a very dark brown or reddish-brown gravelly loam 2 to 3 feet in depth. The gravel is flattened or angular and is derived from many different rocks. The subsoil is slightly lighter in color, and contains more coarse gravel and cobbles, which increase in quantity with depth, often merging into beds of coarse gravel and cobbles at 6 feet. The type is associated with soils of the Pleasanton series and occupies benches and terraces along stream courses. The surface is level. Drainage is excessive and the type is generally treeless. A large part of it is farmed to grain and hay, yields being light except in favorable seasons. It is also extensively devoted to wine grapes, and under irrigation is adapted to alfalfa, fruit, and general farm crops.

Maywood gravelly sandy loam.—This type consists of a grayish-brown sandy loam with a varying content of water-worn gravel and coarse sand. It is of rather porous nature and extends to a depth of 6 feet or more. though sometimes underlain at any depth below 18 inches by beds of incoherent stream gravel or occasionally by a clay loam subsoil. The soil is friable and easily cultivated, but occasionally puddles slightly if handled when too wet. The type occurs as inextensive areas bordering flood plains of intermittent streams. The surface is level or broken by occasional remnants of stream channels. Drainage is well established. The type is practically treeless. The soil is of alluvial origin and of rather recent formation. It is used in the production of dry-farmed grains, and in some cases peaches have been successfully produced without irrigation. Irrigation is necessary to its extensive development, when it can be used for the cultivation of olives, peaches, alfalfa, and various other farm and fruit crops.

Salem gravelly sandy loam.—The soil and subsoil are of light-brown to dark-brown color and underlain by a gravel substratum varying in depth from 1 to 4 feet or more and of loose, open structure. Water-worn basaltic gravel is found throughout the soil section, often representing 50 per cent of the surface material. The surface is often somewhat uneven, requiring leveling for irrigation. The type occurs adjacent to stream channels and to a great extent occupies present stream bottoms. It supports a dense growth of forest. Where deep enough and where moisture conditions are favorable it is adapted to apples, pears, alfalfa, and grains.

Sifton gravelly sandy loam.—The soil is dark brown to black, from 10 to 12 inches deep, and contains a large amount of rounded, water-worn gravel throughout the section. The subsoil is a compact mass of rounded, water-worn gravel and cobbles, the interstitial material consisting of medium to coarse sandy loam or loamy sand. In places the subsoil consists almost wholly of rounded bowlders and cobbles. The topography is gently undulating, broken by numerous low ridges with broad, shallow basins. The coarse, gravelly texture of the subsoil causes drainage to be excessive. The type is sparsely timbered, easily cleared, and with careful cultivation to conserve moisture is adapted to prunes, early vegetables, and small fruits.

Area and distribution of the gravelly sandy loams.

Soil name.	State or area.[1]	Acres.
Sifton gravelly sandy loam	Washington 7	11,520
Livermore gravelly sandy loam	California 8	9,600
Bear gravelly sandy loam	California 17	8,384
Agate gravelly sandy loam	Oregon 4	4,416
Salem gravelly sandy loam	do	3,904
Elma gravelly sandy loam	Washington 5	3,584
Maywood gravelly sandy loam	California 16	2,048
Camas gravelly sandy loam	Washington 7	2,048
Total		45,504

[1] For key to numbers in this column see p. 733.

COARSE SANDY LOAM PHASE.

The coarse sandy loam phase of the sandy loam group of this province is represented by two soil types.

The soils are normally of appreciably coarser texture and more open, pervious structure than the normal members of the sandy loam group, and have a much lower power to retain moisture during periods of drought.

In the Toutle series, characterized by a porous gravelly substratum, the soil, although occurring in a moderately humid and heavily forested region, is droughty and not well adapted to agriculture without irrigation, although some of the earlier truck and fruit crops can be grown with the natural moisture supply under intensive methods of cultivation. But little attempt has as yet been made to use the type for farming.

The coarse sandy loam in the Sacramento series, while of coarse texture, under certain moisture conditions assumes a moderately close and compact structure. Owing to this physical peculiarity and to the fact that the subsoil

is somewhat heavier, the soil is superior to that previously described in moisture-retaining properties, and under similar conditions of environment does not differ essentially in adaptation to crops from the sandy loam of the same series.

Sacramento coarse sandy loam.—The soil consists of a reddish or yellowish to dark chocolate brown, somewhat micaceous sandy loam 6 feet or more in depth, carrying a large quantity of coarse, sharp sand and fine gravel. It is usually loose and incoherent when dry, but somewhat sticky when wet, becoming compact and forming a hard, smooth surface somewhat inclined to clod under field conditions. The soil generally extends to a depth of 6 feet or more, although the subsoil is sometimes slightly heavier in texture and in color than the soil. The type is derived mainly from the sand and gravel beds of the lower foothills forming the basis of the lighter members of the Arnold series, and with the exception of the sandy and incoherent bodies is well adapted to the production of almonds. Under irrigation strawberries and brambleberries can be grown. Olives, melons, and vine and truck crops are also grown upon this type with considerable success.

Toutle coarse sandy loam.—The soil to an average depth of 10 to 12 inches consists of a brown to grayish-brown, light-textured coarse sandy loam. The upper layer, from 1 to 3 inches thick, often contains a large amount of decomposing vegetable matter, which imparts a dark color and loamy texture. The subsoil consists of light-brown, light sandy loam of coarser texture than the surface soil. The material ordinarily extends to a considerable depth below the surface, resting on deposits of coarse gravel and small cobbles. Rounded, waterworn gravel is found in both soil and subsoil. The type occupies elevated terraces rising 10 to 50 feet above the present level of the streams. The topography is level to gently undulating. The coarse, porous texture of the soil and subsoil cause the type as a whole to be excessively drained, of deficient moisture-retaining capacity, and subject to drought. The native timber growth consists mainly of fir and hemlock.

Area and distribution of the coarse sandy loams.

Soil name.	State or area.[1]	Acres.
Sacramento coarse sandy loam	California 13	26,304
Toutle coarse sandy loam	Washington 7	2,304
Total		28,608

[1] For key to numbers in this column see p. 733.

Fine Sandy Loam Group.

The fine sandy loam group is represented in a large number of soil series. There is a wide variation among the individual types in climate, drainage, irrigation conditions, possibility of overflow, character of native vegetation, and economic and transportation conditions as affecting the development of special agricultural industries.

The soils of the group are usually porous and, when favorably situated, well drained. They are friable, readily maintained in good tilth, and are retentive of moisture under intensive cultivation. Lower lying areas are frequently subject to overflow unless protected by levees. The soils often support a dense cover of timber and clearing is difficult and expensive. Leveling and preparing the land for irrigation also require considerable labor and expense.

They are well adapted to the production of alfalfa and, when devoted to dairying or stock raising, forage crops. The heavier grain and grass crops can be grown with moderate success. In general these soils are superior to those of the sandy loam group for all general farming purposes, and demand only a light or moderate farm equipment in machinery and draft stock. They are adapted to the intensive culture of moderately early fruits, small fruits, and staple vegetables. Where climate, subsoil, and moisture conditions are favorable the fine sandy loams of this province are particularly well suited to the growing of peaches, prunes, pears, plums, cherries, apples, grapes, hops, asparagus, sugar beets, and tomatoes, and are in certain areas highly developed to the culture of these products upon an extensive commercial scale. The soils of this group

constitute one of the most important assets of the Pacific coast in the production of special fruit and truck crops.

Anderson fine sandy loam.—This type consists of a light-red to grayish-red fine sandy loam from 3 to 6 feet deep, carrying a moderate amount of small subangular or water-worn gravel. It occurs as narrow strips in bottoms and as narrow valley slopes subject to partial overflow. It represents alluvial deposits from the adjacent red soils of the uplands. With or without irrigation the type is adapted to grapes, peaches, pears, small fruits, grains, and alfalfa, though these crops all do better where irrigation is practiced.

Columbia fine sandy loam.—The soil is grayish, grayish brown, or buff, somewhat micaceous, and of porous structure. The subsoil is usually a fine sandy loam or fine sand of similar or of somewhat lighter color than the soil, though in places underlain at a depth of 3 to 6 feet by stream-laid sands and gravels or streaked with lenses of finer sediments. The type is of recent alluvial origin and occupies stream bottoms and lower terraces. It is derived from a wide variety of rocks, including both acid and basic igneous and metamorphic formations with some of sedimentary origin. The surface varies from smooth and nearly level to uneven, being sometimes eroded, cut by sloughs or stream channels, and in places marked by dunes. It frequently supports a dense growth of cottonwood, willow, or other trees, with vines and brush. It is usually well drained, where not subject to overflow, and is rather low in power to hold moisture, except in areas having a high water table. Where protected from overflow and where the rainfall is adequate or irrigation practiced it is utilized for the production of grains, alfalfa, peaches, and prunes. It is well adapted to early truck and orchard fruits.

Coquille fine sandy loam.—This type consists of 12 inches or more of a friable, buff or brown fine sandy loam, underlain by a sandy loam of fine to coarse texture, grading at 3 feet or more into a loose, porous sandy loam or sand. Occasionally the soil occurs as a surface mantle overlying associated types with heavier subsoils. It occupies the more elevated flood plains and supports a native growth of timber and brush. It is generally well drained. In origin and mode of formation it is similar to the Coquille sandy loam. It is retentive of moisture and well adapted to corn, potatoes, truck, and leguminous crops and bramble fruits.

Evans fine sandy loam.—The soil is light brown in color, distinctly micaceous, and frequently carries water-worn gravel. The type is traversed by intermittent streams and is well drained. Lower lying areas are occasionally subject to overflow. The type generally supports a heavy growth of trees and brush. Under favorable conditions of irrigation or rainfall it is well adapted to alfalfa, peaches, and truck crops.

Lauren fine sandy loam.—The soil is brown to slightly reddish brown and from 10 to 15 inches deep. It is underlain by a light-brown or slightly mottled fine sandy loam or silty fine sandy loam, which becomes heavier with depth, often grading at 3 to 4 feet into a silty clay loam or silty clay. A large quantity of small mica flakes is found in the subsoil. In some localities the surface of the areas occupied by this type consists of a series of small, shallow basins with intervening low mounds. This is an intermediate type between the Lauren sandy loam and the Felida silt loam and does not conform strictly in all respects to the Lauren series. Unlike the other members of the series, the deeper subsoil of this type is underlain by compact, stratified deposits of silts, clays, and fine sands, which contain little or no coarse material. Drainage is usually well developed, but occasionally deficient in local depressions or in the more level areas. The type is adapted to prunes and other tree fruits, small fruit, and vegetables.

Livermore fine sandy loam.—The soil consists of a brown to reddish-brown, fine sandy loam about 2 feet deep, the red tint becoming more pronounced when wet. The subsoil is a yellowish-brown or yellowish sandy loam, of finer texture than the surface soil, grading into a yellowish medium sand or loamy sand at depths of 5 and 6 feet. In some areas both the soil and subsoil carry gravel. The type is well drained and treeless. Hay and grain are the principal crops, yields being somewhat lighter than on the Livermore loam. Under irrigation the type could be utilized for small fruits, truck, and alfalfa.

Maywood fine sandy loam.—The soil consists of a yellowish-gray fine sandy loam from 24 to 30 inches deep, of friable structure and carrying moderate amounts of water-worn gravel. The subsoil is usually composed of loam or gravelly loam, though in places gravel beds or a light clay loam underlie the soil. The type occurs as narrow, elongated bodies occupying minor stream

valleys. The topography is level, but frequently marked by shallow, winding stream beds or by remnants of former stream courses. It is separated from adjacent types by well-defined terraces, or merges into surrounding soils by definite degrees. It occasionally supports a scattered growth of valley oak and during rainy periods a luxuriant growth of native grasses. It is generally devoted to the production of dry-farmed grains. The production of fruits without irrigation has been developed to a slight extent and with only partial success. Under irrigation alfalfa, peaches, prunes, apricots, and other fruits, melons and truck crops can be grown profitably.

Mocho fine sandy loam.—The type consists of a light-textured, porous, brown to grayish-brown, fine sandy loam, 18 to 24 inches deep, carrying small amounts of gravel. It is underlain by thin, alternating strata of grayish-brown fine sandy loam and fine sand, marked with gray or yellow and becoming quite silty in the lower portion of the section. The surface is generally level, except where marked by depressions and ridges along former stream channels. Drainage is well established. The type is entirely under cultivation and devoted principally to sugar beets and hops.

Neal fine sandy loam.—The soil is of variable texture, from 1 to 6 feet or more in depth, and carries in places thin lenses of fine gravel, and coarse, sandy, granitic bowlders are sometimes present. The topsoil is normally underlain by a lighter colored material of heavy texture, by shales, or locally by water-worn gravel. The surface is sloping and frequently uneven. Drainage is fairly well developed and the type rarely subject to overflow. It is adapted to grains, alfalfa, and tree fruits.

Pajaro fine sandy loam.—The soil consists of a light-brown, micaceous, fine sandy loam varying in depth from 18 inches to 6 feet, the depth being greater near the streams which have laid the material down. The soil usually rests upon a subsoil of black loam or silt loam. This type is easily tilled, holds moisture well, and is adapted to apples, small fruits, alfalfa, and garden products.

Puget fine sandy loam.—The soil is a dark-gray to brown fine sandy loam from 12 to 15 inches deep, sometimes marked by iron stains, is friable, and rather incoherent. The subsoil is lighter in color and texture and iron stained. It is sometimes marked by layers of clay or sandy clay. It occurs in stream valleys as low ridges or level areas. Drainage is good, but the type is sometimes subject to overflow. Willow is the characteristic tree growth. This soil is extensively cultivated and devoted mainly to forage crops and pasture, although well adapted to fruits.

Sacramento fine sandy loam.—The soil consists of a loose, porous, micaceous, fine sandy loam of light yellowish brown or light-gray color, usually 6 feet in depth, though sometimes less. It is frequently gravelly, is underlain by river sands or gravels, and occurs as inextensive, long, narrow, or irregular bodies. The surface is often eroded or uneven. The areas support a dense growth of vines, brush, and forest trees. The type is subject to overflow. It merges gradually into adjacent soil types and when cleared, leveled, and placed under irrigation is well adapted to the production of alfalfa, truck crops, and fruits.

Salem fine sandy loam.—The soil is a brown fine sandy loam and is underlain by a subsoil of similar character. This rests upon a substratum of water-worn gravels, sometimes compact and cemented in its deeper portion, and occurring usually at depths between 18 inches and 6 feet. The soil in many places contains small quantities of water-worn gravel, often in the form of thin lenses or strata. The type occupies bottom lands and is of somewhat irregular surface. Drainage is good and overflows infrequent. The type is alluvial in origin, occupying stream bottoms and terraces. It supports a heavy growth of forest trees and underbrush. It is adapted to alfalfa, apples, pears, small fruits, and vegetables.

Vina fine sandy loam.—The type consists of a dark-gray or grayish-brown to nearly black, friable, fine sandy loam of somewhat micaceous character, 6 or more feet in depth. The type is of uniform character throughout and ordinarily free from gravel. The topography is smooth, and level or slightly sloping. Gentle depressions of deficient drainage are of occasional occurrence. This soil supports a vigorous growth of willow, cottonwood, and underbrush. Irrigation can be practiced over most of the type. Dry-farmed grains give good yields, but the type is better adapted to alfalfa, peaches and other fruits, grapes, melons, and truck crops under irrigation.

Area and distribution of the fine sandy loams.

Soil name.	State or area.[1]	Acres.
Puget fine sandy loam	Washington 4, 5, 7	128,704
Sacramento fine sandy loam	California 12, 18, 25	35,776
Lauren fine sandy loam	Washington 7	20,736
Columbia fine sandy loam	California 2, 16, 17	14,720
Vina fine sandy loam	California 16	8,768
Salem fine sandy loam	Oregon 4, 5	6,912
Coquille fine sandy loam	Oregon 3	4,736
Anderson fine sandy loam	California 17	3,520
Neal fine sandy loam	Oregon 4	2,368
Pajaro fine sandy loam	California 14	2,048
Evans fine sandy loam	Oregon 4	1,920
Maywood fine sandy loam	California 16	1,536
Mocho fine sandy loam	California 8	512
Livermore fine sandy loam	do	448
Total		232,704

[1] For key to numbers in this column see p. 733.

GRAVELLY FINE SANDY LOAM PHASE.

The gravelly fine sandy loams of this province have been mapped over a small area, and are represented by only two types. These soils are in both cases underlain by porous, gravelly subsoils and are leachy and deficient in moisture-holding capacity. They are more difficult to handle than the non-gravelly soils of fine sandy loam texture, and under irrigation require more frequent and larger applications of water.

The gravelly fine sandy loam soils occur under semiarid conditions in the interior and coastal valleys of California. They are devoted mainly to grazing or dry farming, or to grains or grain hay, the yields usually being light. They are not well adapted to general farming, but under irrigation give good results with peaches, apricots, and other stone fruits suited to the lighter soils, and to early truck crops and small fruits. Alfalfa can be successfully grown with copious irrigation. The gravel in the soil adapts it to a distinctly lighter type of farming than the fine sandy loams of the same series.

Elder gravelly fine sandy loam.—The soil consists typically of a dark-gray fine sandy loam carrying water-worn gravel, often in excessive amounts. The soil frequently extends to the depth of 6 feet or more, but may be underlain at any depth below 18 inches by stratified deposits of sand, silt, and gravel. The type occupies stream bottoms but slightly elevated above the present water level. The surface is broken or uneven and often traversed by gullies or remnants of former stream channels. The type supports a considerable growth of brush with occasional trees. It is inclined to be porous and leachy and requires frequent and copious irrigation for the profitable production of crops, of which alfalfa and fruits give the best result.

Mocho gravelly fine sandy loam.—The soil consists of a brown, dark-gray, or dark grayish yellow fine sandy loam from 10 inches to 3 feet deep, carrying varying amounts of water-worn gravel. It is underlain by a bed of coarse gravel, many feet in thickness and with but little fine material. The surface is comparatively level, but interrupted by occasional abandoned stream channels. Drainage is excessive. Many large sycamore trees are distributed over the type. It is derived mainly from material washed from the gravelly soils of the Pleasanton series, and is dry farmed to grain or hay, which gives light yields, or is utilized for grazing.

Area and distribution of the gravelly fine sandy loams.

Soil name.	State or area.[1]	Acres.
Mocho gravelly fine sandy loam	California 8	3,136
Elder gravelly fine sandy loam	California 16	832
Total		3,968

[1] For key to numbers in this column see p. 733.

SILTY FINE SANDY LOAM PHASE.

This phase of the fine sandy loam group of soils includes those of distinctly silty texture. Material of this character has been encountered in this province in but one locality, where it is of small extent. It is somewhat heavier and less porous than the fine sandy loam of the series and, under favorable conditions, somewhat more retentive of moisture.

In the locality in which it occurs it is devoted to fruits without irrigation, but the rainfall is scanty and the type rather droughty for the best results. Under intensive cultivation truck crops and alfalfa are somewhat more profitable.

Under irrigation, which has not yet developed in the area mapped, it should prove well adapted to the general farm, fruit, and truck crops of the fine sandy loam group.

Livermore silty fine sandy loam.—The soil consists of a fine sandy loam about 3 feet deep, ranging from brown to slightly reddish brown. The subsoil is a yellowish-brown to brown, light-textured fine sandy loam. The topography is level to slightly rolling, with frequent depressions marking abandoned stream channels. Valley oaks are scattered over virgin areas. Considerable areas are planted to tree fruits, the yields often being light or the fruit of small size on account of lack of moisture. A small acreage is occupied by alfalfa and truck crops. The type is not irrigated.

Area and distribution of the silty fine sandy loam.

Soil name.	State or area.[1]	Acres.
Livermore silty fine sandy loam	California 8	832

[1] For key to number in this column see p. 733.

LOAM GROUP.

The loam soils occupy extensive areas of the River Flood Plains and Terrace province of the Pacific Coast region and have been recognized in various parts of the province. They are subject to a wide range in climate, drainage conditions, and character of underlying material.

In western Washington the loams are devoted to oats, clover, timothy hay, hops, fruits, and truck crops. The climate and soil conditions favor dairying and the production of hay and oats. Hops, apples, pears, plums, small fruits, and the later and hardier truck crops constitute the principal intensively cultivated products. In certain districts only those fruits and vegetables that can resist occasional light summer frosts can be safely grown.

In Oregon the group is represented by a single soil type. It is rather deficient in moisture-holding capacity, but is well adapted to hay crops, including clover, alfalfa, and timothy, and to pears and apples, small fruit, and vegetable products under irrigation.

In California the soils are grouped in a number of series occurring prominently in the Sacramento, coastal, and coastal-intermountain valleys. In the interior valley they are sometimes rather poorly drained and subject to extensive overflow during periods of flood where not protected by dikes. Some of the soils of locally better moisture conditions are capable of successful utilization without irrigation. In other localities the soils are less retentive of moisture or so situated as to be more thoroughly drained, and without irrigation such types can be used for farming only at the cost of constant and intensive cultivation. In other sections irrigation is absolutely essential to the production of crops. Areas subject to overflow and poorly drained are used mainly for pasture.

Where moisture conditions are favorable the loams are utilized quite extensively for grains, alfalfa, and forage crops, and in certain localities have been highly developed for the culture of grapes, tree fruits, hops, and truck crops. Peaches, almonds, apricots, prunes, and pears are the most common of the tree fruits. Olives and figs are grown to less extent. The soils are usually well adapted to alfalfa, sugar beets, and medium early to late vegetables. Some of the members of the group are particularly adapted to certain varieties of grapes.

In the coastal valleys hops, sugar beets, small fruits, alfalfa, the later or heavier vegetables, and stone fruits are usually grown.

The loam group of soils of this province are friable and easily maintained in good tilth. They require only a moderate outlay in farm equipment and are economically and effectively used in small tracts under intensive cultivation. They are well suited to the general farm crops and to dairying or stock raising and constitute one of the most important soil groups of the Pacific Coast region.

Bear loam.—This type consists of a reddish-brown, sticky silt loam from 4 to 6 feet deep, grading into a very dark brown loam below 4 feet. Where less than 6 feet deep it is underlain by water-worn, sandy gravel. The higher lying portions of the type have excellent drainage and are free from overflow, but the lower areas are occasionally inundated during flood periods. The surface is generally level, though broken by occasional gullies. Grain hay is the principal crop. Lower lying areas bear a heavy growth of native grass, which is cut for hay or grazed off. The type is an excellent soil for alfalfa, grapes, and stone fruits, and can also be used for hops.

Chehalis loam.—The soil consists of a yellowish-brown to dark-brown loam 12 inches deep, underlain by a dark-brown sandy loam. Near the stream banks the soil is often a fine sandy loam, while farther back it merges gradually into a silt loam. The type is slightly rolling along the streams, becoming nearly level farther back. Drainage as a whole is good. The soil is well adapted to fruits and truck crops capable of withstanding slight midsummer freezes. Hops also do well. Practically all of the type is under cultivation.

Elma loam.—This type consists of a light-brown to brown heavy loam about 12 inches deep. The dry cultivated surface assumes a grayish tinge. It is underlain by a lighter colored sandy clay loam which becomes heavier in texture and more compact as depth increases. At 3 to 8 feet an incoherent mass of coarse glacial gravels is encountered. Both soil and subsoil contain many mica flakes. The type includes small areas of sandy loam and fine sandy loam. The topography is level and the land easily cultivated. The Elma loam is derived chiefly from alluvium overlying glacial material. The type occurs as small, irregular bodies along minor streams emptying into the Chehalis River. A large part of it is under cultivation. It is well adapted to oats, hay, clover, apples, pears, plums, and small fruits.

Feather loam.—The soil consists of 6 feet or more of a deep-brown loam with a smooth, silty texture. The natural drainage over the greater part of the type is poor, water accumulating on it from surrounding types. When the river levees break these areas are flooded. The type is alluvial in origin and subject to modification at each period of flood. Owing to danger from overflows a large part of this soil has never been cultivated. It supports a heavy growth of grass and is used for pasture. Where drained and protected from overflows the soil is very productive.

Gridley loam.—This type consists of a light reddish brown loam from 2 to 6 feet deep, underlain by a heavy, sticky, dark reddish brown clay loam. Most of the type rests upon a gray, calcareous hardpan at an average depth of 3 feet, overlain in most cases by a layer of compact clay loam encountered below the soil. The type occupies a slightly uneven plain with numerous shallow depressions, having no outlet. Both surface drainage and subdrainage are deficient, owing to lack of surface channels and the impervious underlying hardpan. The depressed spots usually contain water during the rainy season. Artificial drainage is necessary for the intensive development of the type, which is occasionally inundated from river overflow. Under favorable drainage conditions the type is well adapted to fruits, including peaches, pears, apricots, apples, grapes, and figs. Alfalfa does well.

Honcut loam.—The type consists of a light reddish brown loam 2 feet deep, underlain by a very dark red loam extending to a depth of 6 feet or more. Water-worn gravel is sometimes present in this soil near stream courses, but is not an essential feature of the type. The surface is level and the natural drainage fair. The type is of alluvial origin. It is used mainly for pasture and hay, but is fairly well adapted to the growing of truck crops, alfalfa, and fruits.

Livermore loam.—The soil is brown or slightly reddish-brown loam, of rather silty texture, containing relatively large proportions of sand of the fine and very fine grades. Varying quantities of gravel are usually present in the soil. It is retentive of moisture. The subsoil is a brown, yellowish-brown, or reddish-yellow silty to fine sandy loam, slightly lighter than the soil but becoming heavier at 2½ to 3 feet and sometimes grading to yellowish silt loam at 5 or 6

feet. The surface is generally level or broken by old stream channels. The type often supports a few valley oaks. It is generally well drained and devoted mainly to hay and grain, which produce good yields. Grapes, tree fruits, and almonds are grown. The two latter often suffer for moisture, the land not being irrigated.

Maywood loam.—The type consists of a light-gray or yellowish-gray, smooth, silty loam from 24 to 30 inches deep, underlain by a compact yellowish clay loam. Gravel beds are occasionally encountered at a depth of about 6 feet, marking the courses of former drainage ways. The type is friable, coarsely cultivated, and retentive of moisture.

The surface is of uniform, slightly sloping character, and less frequently marked by local depressions than most of the other members of this series. It is traversed by occasional minor washes or shallow intermittent stream courses. Originally the type was extensively dry farmed to grains, but large areas have been subsequently laid out in orchards with indifferent success. In the most favorable locations it is capable of developing successful dry-land orchards, but only where accompanied by efficient methods of preparation and cultivation of the land and by the selection of crops and varieties adapted to prevailing conditions. Under irrigation it is adapted to a wide range of fruit and general farm crops.

Mocho loam.—The soil is subject to considerable variation, but typically consists of a dark-brown or dark-drab loam, or in places sandy clay loam, of silty texture, and 18 to 24 inches deep. It is underlain by alternating strata of grayish-brown sand, fine sand, and silty fine sand grading, at 3 to 5 feet, into a heavy black clay or dark-drab silty clay loam mottled with yellow and gray. The material is of alluvial origin. Land of this type is comparatively level and is devoted to the production of fruits, hay, and grain. Potatoes and truck crops have also been successfully grown.

Pajaro loam.—The soil consists of a heavy, dark-brown to black micaceous loam from 12 to 18 inches deep. It is underlain to a depth of 6 feet or more by a light-yellow silt loam, becoming more micaceous with depth. The mica in the top soil is largely obscured by the large content of humus. Although the soil is heavy, on account of the high percentage of humus and lime, it is usually easily cultivated. Long, irregular bodies of this soil extend along the Pajaro River. It is adapted to alfalfa, sugar beets, onions, and small fruits.

Sacramento loam.—The soil consists typically of a rather heavy, sticky sandy loam or loam carrying more or less gravel and extending to a depth of 6 or more feet. It is sometimes underlain at a less depth by stream sands and gravels. It occurs as long, narrow, or moderately extensive bodies in the vicinity of former or present stream channels. Under irrigation it is generally well adapted to the production of alfalfa, fruits, and, where not too gravelly, of sugar beets.

Sams loam.—The soil and subsoil material are usually of similar loam texture and friable structure, though in places the latter is somewhat heavier than the overlying material. It is of brown color, which is frequently of rather dark tint. Gravel rarely occurs. The surface is generally uniform and evenly sloping and favorable to irrigation. The type is frequently separated from lower lying, alluvial types by low terrace slopes. It is somewhat low in moisture-retaining capacity, but under irrigation is adapted to pears, apples, and hay crops.

Santa Rita loam.—This is a gray, slate-colored, or nearly black loam, sometimes faintly mottled with bluish gray and brown, about 3 feet deep. It is underlain by a gray to brown loam similar in texture to the soil, but sometimes somewhat mottled with gray and yellowish brown. The type is comparatively level and well drained. It is entirely under cultivation and devoted mainly to hops, sugar beets, and fruits. The hop yields are large and the sugar-beet yields good in favorable seasons. Alfalfa is successfully grown in favorable localities.

Vina loam.—The soil consists of a smooth brown to reddish-brown loam from 20 to 36 inches deep, frequently of somewhat silty character and carrying small quantities of andesitic gravel. It is underlain by gravel beds, although at times the type rests directly upon the unweathered parent rock of schist or andesite. The type occurs as fan-shaped bodies in the vicinity of stream deltas. The surface is gently sloping and often marked by stream courses and abrupt terrace lines. In its natural condition it supports a growth of oaks and other trees and brush. With the exception of the deeper phases, it is not well adapted to the production of fruits without irrigation, or to alfalfa or the fruits requiring the

deeper soils. A deep silty phase of this type has been encountered, occupying a somewhat lower position than the typical soil. This phase is of superior value for the production of both dry-land and irrigated crops and is well adapted to peaches, prunes, grapes, sugar beets, alfalfa, and truck crops.

Area and distribution of the loams.

Soil name.	State or area.[1]	Acres.
Gridley loam	California 12	65,728
Bear loam	do	10,816
Feather loam	do	8,704
Maywood loam	California 16	8,576
Vina loam	do	5,440
Pajaro loam	California 14	5,120
Sams loam	Oregon 4	4,672
Sacramento loam	California 17	4,480
Elma loam	Washington 5	3,840
Livermore loam	California 8	3,520
Honcut loam	California 12	2,816
Chehalis loam	Washington 5, 7	2,304
Santa Rita loam	California 8	832
Mocho loam	do	576
Total		127,424

[1] For key to numbers in this column see p. 733.

STONY GRAVELLY LOAM PHASE.

This phase includes soils containing sufficient gravel and larger stone fragments or bowlders to alter essentially the agricultural value. The interstitial material is ordinarily of loamy texture. The phase is represented in this province by a single soil type.

The soil is underlain by a porous, gravelly substratum, which, with the gravel and stone content of the soil itself, renders the type of porous texture unretentive of moisture, and subject to drought. The type is of limited extent and of minor agricultural importance, being inferior to the loams for the production of ordinary crops. It is unsuited to general farm crops, but under irrigation or intensive cultivation areas in which the stone and gravel content is not too high could be utilized for early apples, stone or small fruits, and early truck crops. It is not at present farmed to any extent.

Camas stony gravelly loam.—The soil consists of a light-brown to dark-brown gravelly loam or clay loam 8 to 12 inches deep. The subsoil is a brown to light-brown loam or clay loam, usually more gravelly than the soil. From 40 to 90 per cent of the soil mass often consists of gravel, cobbles, and rounded basaltic bowlders. The type occurs on low terraces or alluvial fans formed at the mouths of creeks. The topography, owing to frequent low mounds and shallow depressions, is uneven and undulating. Drainage over the more stony and gravelly areas is very thorough, but where the soil contains a large proportion of fine material it retains moisture very well. The type supports only a stunted and sparse growth of fir, with a few small scrub oaks. It is of little agricultural importance, but includes some small areas which could be utilized for fruit culture.

Area and distribution of the stony gravelly loam.

Soil name.	State or area.[1]	Acres.
Camas stony gravelly loam	Washington 7	512

[1] For key to number in this column see p. 733.

GRAVELLY LOAM PHASE.

In the gravelly loam soils the stone content is not as great as in the stony gravelly loams. The proportion of fragmental rock is, however, sufficient to modify the normal physical characteristics of the loam soil and is often excessive.

In the River Flood Plain province gravelly loams have been recognized in four soil series mapped in the semiarid and subhumid districts of the California interior valley and of southern Oregon. In the latter region one of the series represented is characterized by an impervious hardpan substratum, the other by a porous, gravelly substratum. The former type is well elevated above present flood plains and under normal conditions is well drained, often shallow, and not adapted to crops except under irrigation. When developed the soil will require frequent applications of water and careful management in order to guard against poor underdrainage due to the impervious hardpan strata. The shallower areas are adapted only to shallow-rooted crops, such as berries and small grains, or may be used for grazing. The areas of deeper soil, when improved by blasting, will become suitable under irrigation for the production of peaches, small fruits, and early truck crops. The lower lying type having a porous substratum is farmed to some extent, and where not too gravelly is suitable for the production of grains, apples, and pears under favorable moisture conditions.

In the California Valley the gravelly loams occupy valley plains free from overflow. They are well drained and favorably located for irrigation. The moisture-holding capacity is low and they are not adapted to dry-farmed crops and are utilized mainly for grazing. Under irrigation they are suited to the production of peaches, apricots, olives, prunes, grapes, alfalfa, small fruits, and early vegetables.

The characteristics of the gravelly loam series favor the production of grapes, moderately early stone fruits, and small fruits. The soils are not so well adapted to the general farm crops, late tree fruits, or staple vegetables as the members of the loam group. In adaptation they are more closely associated with the soils of sandy loam or fine sandy loam texture than with the loams.

Agate gravelly loam.—The soil is reddish brown to brown in color and subject to considerable variation in depth, ranging from 6 inches or less to about 4 feet. The fine earth, which is a loam, carries much water-worn gravel, the fragments being small to medium size. In local depressions gravel has accumulated on the surface, and small basaltic bowlders also occur. Surface drainage is but fairly well developed and the subdrainage poor. The surface is marked by "hog wallows." The deeper phases of the type support a scant growth of timber and brush; the shallower areas are treeless. Where of sufficient depth and irrigated the type is adapted to peaches, small fruits, and truck crops. The shallow bodies are adapted only to grazing or shallow-rooted crops.

Anderson gravelly loam.—The soil is a heavy, sticky, light-red loam 8 to 12 inches deep, carrying a moderate quantity of small pebbles, cobbles, and fine gravel. The subsoil varies from almost pure gravel to a clay loam. The type occupies elevated valley plains or valleys, has a nearly level or gently sloping surface, and is usually well drained. It is of comparatively recent alluvial origin, being derived from the elevated formations of early stream gravels and sediments of the uplands. Under irrigation it is well adapted to peaches and grapes. Alfalfa is also grown under irrigation, but most of the land is utilized for grazing.

Salem gravelly loam.—The soil is a brown to black loam from a few inches to several feet in depth, containing a large quantity of gravel, varying in size from fine gravel to pebbles 2 or 3 inches in diameter. The subsoil is practically the same as the soil, except that it contains more gravel. It rests on a bed of water-worn gravel. This is a bottom-land soil. It is generally well drained and covered with a growth of brush and scrub oak. Where not too gravelly it is fairly well adapted to grain and fruit.

Tehama gravelly loam.—The soil is a yellowish-brown to reddish-gray, compact loam from 18 inches to 6 feet deep, carrying water-worn gravel, coarse sand, and subangular rock fragments. It bakes upon exposure to dry weather, but can be readily handled under proper moisture conditions. Where less than 6 feet in depth it is underlain by a compact, impervious clay loam or clay. The type is found as inextensive, elongated bodies bordering the flood plains of intermittent streams or as terraces or bench lands in minor stream valleys. The topography is level to slightly sloping and the surface treeless. Drainage is good and the type mainly devoted to dry-farmed grains. The surface configuration favors irrigation, and where this is practiced the type should prove well adapted to the production of alfalfa, truck crops, and fruits, particularly peaches, olives, and apricots.

Area and distribution of the gravelly loams.

Soil name.	State or area.[1]	Acres.
Agate gravelly loam	Oregon 4	24,704
Anderson gravelly loam	California 17	14,528
Salem gravelly loam	Oregon 5	13,120
Tehama gravelly loam	California 16	4,032
Total		56,384

[1] For key to numbers in this column see p. 733.

Silt Loam Group.

The silt loam group includes a large number of extensive and widely distributed soils and constitutes one of the most important soil groups of the River Flood Plain province. Owing to their wide distribution throughout those portions of the States included within the Pacific coast region, the soils vary widely in climatic environment, drainage conditions, possibilities of irrigation, and other features affecting their utilization.

In the humid, heavily forested regions of western Washington and southwestern Oregon, where the silt loams have been extensively mapped, they are confined to the river bottoms and are sometimes subject to overflow. Where well drained and protected from inundation, they are friable under cultivation, retentive of moisture, and extensively utilized for the production of hay and forage crops, dairy products, grains, potatoes, and the later and heavier vegetables. Small fruits, consisting mainly of brambleberries, are extensively grown locally, and yield heavily, but tree fruits do not show such good results. Of the grains oats are most extensively grown and produce unusually heavy yields. Climatic conditions are generally unfavorable to the production of wheat of good milling quality. Of the hay crops clover, timothy, and native hay are most successful. In the Columbia River Valley in Washington members of the group occupy stream terraces, generally well elevated above present flood plains. In some cases, owing to their elevated position and porous substratum, they are excessively drained, but under intensive cultivation are usually retentive of moisture. They are extensively utilized for the production of forage crops, dairy products, and prunes. Apples, pears, small fruits, and vegetables are grown to some extent, though the production of these fruits might well be increased. The better drained areas are not so well suited to hay and the general farm crops as those underlain by more compact material, but are better adapted to orchards and small fruits.

In the interior districts of more limited rainfall in Oregon the silt loams are utilized mainly for grazing and the growing of wheat, oats, and hops, and are also adapted to hay and forage crops, sugar beets, small fruits, and late vegetables.

In the interior California Valley they occur under semiarid climatic conditions. Some of the areas encountered lie well above present flood plains, while others occupy a position adjacent to stream channels, and where not protected by levees are subject to periodical overflow and are poorly drained. Some members of the group have porous subsoils and are subject to excessive underdrainage; in others the underlying material is compact and less pervious, making the soils retentive of moisture. The low, poorly drained, or overflowed areas are utilized mainly for pasture; the better drained areas are devoted extensively to grains without irrigation. With the exception of the areas in which drainage is excessive, the soils retain enough moisture to insure fair average yields. The elevated and well-drained areas are not generally suited to fruits, alfalfa, or special crops, except under irrigation. In some of the lower-lying soils irrigation is unnecessary, and hops, prunes, grapes, alfalfa, beans, asparagus, potatoes, and other vegetables are profitably grown. The production of sugar beets has in some sections become an established industry. Forage crops, dairy products, and pears also form important sources of revenue, particularly in the lower lying areas near the larger streams. The silt loams of the smaller valleys near the coast are devoted to grain, alfalfa, sugar beets, prunes, apricots, apples, small fruits, and vegetables.

The silt loam group meets the requirements of a soil adapted to general farm crops, dairying, and to special intensively cultivated products. Those of the

latter class include sugar beets, prunes, pears, asparagus, potatoes, beans, hops, the later vegetables, such as cabbage, cauliflower, onions, etc., small fruits, apples in the localities of suitable climatic conditions, and tomatoes, apricots, and peaches upon the better drained or earlier areas or when intended for canning purposes. In the range of crops which can be profitably grown under the varying climatic and other local conditions, the soils probably exceed any other group of soils of the Pacific coast region.

Camas silt loam—The typical soil consists of a light-brown to brown silt loam about 12 inches deep, often carrying fine water-worn gravel and spherical iron pellets scattered over the surface and mixed with the soil. Small, rounded bowlders also occur in the soil, but are seldom found in sufficient amounts to interfere with cultivation. The subsoil is usually a brown to light-brown silt loam, usually of compact character, but sometimes moderately pervious, becoming heavier with depth, and grading at about 24 inches into a light yellowish brown silty clay loam. A small amount of gravel and a few rounded bowlders occur throughout the subsoil. At an average depth of 4 to 6 feet the subsoil is underlain by an imperfectly stratified deposit of gravel, which may occasionally approach the surface. Rounded bowlders varying in size from cobbles to fragments several feet in diameter are found embedded in this gravel deposit. Drainage is well established and in some cases is excessive. The type is generally retentive of moisture and well adapted to diversified farming, dairying, hay crops, fruits, etc. The areas in which the underlying, porous substratum occurs at shallow depths are rather droughty and require intensive cultivation for successful crops.

Coquille silt loam.—The soil is a grayish or light-brown micaceous silt loam from 15 to 30 inches deep. It is underlain by a bluish-drab or light-brown heavy silt loam or silty clay, often mottled with iron stains and with dark patches due to undecayed vegetable material. The type occurs as bottom lands in stream valleys and in the vicinity of sloughs and inlets entering tidal bays and estuaries. It is often poorly drained or subject to inundation by high tides and more or less water-logged. It is usually covered by a growth of juncus, marsh grass, tules, or salt grass, or by a tangled forest growth of fir, myrtle, and willow. In the vicinity of tidal marshes it often carries excessive accumulations of marine salts, but where protected from overflow by tides or streams and drained it is productive and well adapted to the production of potatoes, root crops, vegetables, vetch, hay, and grain crops.

Elder silt loam.—The soil is a smooth-textured, friable silt loam, 6 feet or more in depth, and of grayish to dark-gray or black color. The black color is due to accumulations of organic matter. The surface is level or marked by occasional remnants of former waterways or by minor stream courses. The type is well drained and not subject to overflow. It supports a growth of valley oak and thickets of elder, willow, and brush. Where cultivated it is dry-farmed to grains, and under irrigation is well adapted to the production of alfalfa and fruits crops. Sugar beets, berries, and other small fruits, melons, and truck crops, should do well.

Feather silt loam.—This type consists of a reddish-brown to very dark brown silt loam 6 feet or more in depth. Thin layers of fine sandy loam are found throughout the subsoil. The type is known locally as "black land." The soil is formed largely from stream-deposited material, the areas being subject to annual overflow. Small tracts are cultivated to alfalfa and sorghum, but the yields are uncertain on account of the floods. The soil is well adapted to alfalfa, truck crops, and small fruits.

Felida silt loam.—The soil is a gray to black compact silt loam, sticky when wet, extending to a depth of 12 to 15 inches, and containing a few small, rounded, iron-cemented pellets and a considerable amount of very fine sand. The subsoil is a light-brown to slightly mottled heavy silt loam which grades into a silty clay loam at a depth of 3 to 4 feet. A noticeable amount of mica particles is always present in the subsoil. Small pockets of gravel occur in the soil and subsoil, but on the whole the type is free from coarse sands, gravel, or bowlders. The topography varies from comparatively level to gently rolling. The type is devoted to prunes and other tree fruits, clover, timothy, forage crops, and small fruits.

Lauren silt loam.—The soil is a brown to slightly reddish brown loam, compact, and friable, and from 10 to 12 inches deep. It is underlain by a compact, yellowish-brown silt loam, which rests at depths of 20 to 30 feet upon a bed of gravel and rounded cobbles. The type occupies valley terraces rising from 250 to 300 feet above the bottoms. The topography is level to gently

undulating, but the slopes toward the river valley are steep and abrupt. The type as a whole has good natural drainage. It is well adapted to prunes, pears, apples, small fruits, and vegetables.

Livermore silt loam.—The soil is a light-brown to dark-brown silt loam, of rather compact structure, becoming sticky when wet, and tending to puddle and bake. With proper cultivation and favorable moisture conditions it becomes friable. The subsoil differs but little from the soil material, except that in the deeper portion the color and texture are somewhat lighter than the soil. The type is of alluvial origin and occupies level to slightly depressed river flood plain or terrace areas. It is derived mainly from a variety of metamorphic, crystalline, and sedimentary rocks. It is often poorly drained and in such places devoted only to grazing. Where well drained it is retentive of moisture and adapted to asparagus, fruit, grain, and hay crops.

Marysville silt loam.—This type consists of a light-brown silt loam from 18 inches to 4 feet deep, underlain by 10 to 20 inches of reddish-brown sticky clay loam, which in turn rests upon a mottled gray hardpan. In places a layer of fine gray silty material is found overlying the hardpan. The type is more or less subject to overflow and the surface drainage is poor, although the soil dries out rapidly after the floods subside. Where protected from overflow and provided with artificial drainage it is adapted to alfalfa, grapes, and stone fruits.

Maywood silt loam.—The soil consists of a compact, slightly sticky, yellow to yellowish-gray silt loam which proves friable when handled under favorable moisture conditions. It is usually free from gravel and underlain at depths of 30 to 36 inches by a compact clay loam or silty loam of high water-holding capacity. This in many places rests upon gravel beds at a depth of 6 feet or more. The surface is level and the type well drained. It is of alluvial origin, occupying minor stream valleys, and sometimes supports a considerable growth of valley oak, with some willows and cottonwoods. It affords good grazing, supporting a fair growth of native grasses during the rainy season. It is fairly well adapted to dry-farmed crops and with careful cultivation has produced fair returns when devoted to alfalfa and to orchard crops without irrigation. It is best adapted, however, to the production of such products under irrigation.

Pajaro silt loam.—This type consists of a smooth, brown, micaceous silt loam, becoming more micaceous and lighter in color below 3 feet. The subsoil extends to 30 feet or more. Very little sand and no gravel is found, the type being uniform in texture. It is a fertile soil, well adapted to apples, and also to alfalfa, sugar beets, garden truck, and berries.

Puget silt loam.—The soil consists of a light-brown silt loam 8 to 20 inches deep, carrying a relatively large proportion of sand of the finer grades. The subsoil is a light-brown to gray fine sandy loam, often slightly mottled with yellow iron stains. The topography as a whole is gently undulating. Areas bordering the larger streams are subject to overflow at times of high water, but the natural drainage of the greater proportion of the type is fairly good. Artificial drainage will improve many of the areas, especially in the shallow basins or depressions. The fine silty texture makes the soil easy to cultivate, and when thoroughly drained and well cultivated it is very productive. It is well adapted to small fruits and to oats and other grass crops. Clover, timothy, potatoes, vegetables, and Canadian field peas produce very profitable yields.

Sacramento silt loam.—This type consists of a light yellowish brown to drab, micaceous silt loam, usually 6 or more feet deep and of moderately porous and friable structure. In some places strata of river sands and gravels come within the 6-foot profile. The type occurs as elongated, narrow bodies near present or former stream channels, or as broad, extensive areas covering the river flood plains. The more elevated bodies are well drained, but those lying near stream courses are often subject to overflow. The type supports a dense growth of vines, brush, and timber, and is more or less eroded. Grain and hops are grown by dry-farming methods, and when protected from overflow and irrigated the type is very well adapted to the production of alfalfa, sugar beets, truck crops, and prunes, pears, or other fruits.

Salem silt loam.—The soil is a brown to black silt loam 18 to 24 inches deep, carrying considerable organic matter. The subsoil is a yellowish to red clay loam, often mottled with gray and yellow, becoming heavier with depth. The type occupies gently rolling or level valley land and is derived from transported shale and sandstone material, modified somewhat by material derived from basaltic rocks. Drainage is good, except in a few local depressions. The soil is

well adapted to genearl crops, hops, and small fruits. Wheat yields from 25 to 30 bushels, oats from 35 to 50 bushels, and hops about 1,500 pounds per acre.

Tehama silt loam.—The soil is a yellowish-brown to reddish-yellow, compact and friable silt loam from 10 to 20 inches deep. Fine gravel or coarse sand, distributed by former washes or intermittent drainage courses, is formed over the surface. The subsoil is a tenacious brown or yellowish-brown silty clay loam of rather impervious character, extending to the depth of 6 feet or more, underlain by compact, partially consolidated sand, silt, and gravel. The type occupies slightly lower situations than the soils of the Redding and Corning series, from which it is frequently separated by pronounced slopes and terraces. It is found on the upland plains having a gentle slope and is generally treeless, except in the vicinity of small streams, where a scattering timber growth is sometimes found. The surface is marked in places by the courses of intermittent streams, but surface drainage is in general restricted, and many poorly drained depressions exist. The type in many places has a "hog-wallow" topography. Land of this type, where used, is devoted to dry-farmed grains. With irrigation it should prove adapted to a wide range of general farm and fruit crops, including particularly stone fruits and alfalfa.

Area and distribution of the silt loams.

Soil name.	State or area.[1]	Acres.
Sacramento silt loam	California 2, 12, 13, 16, 17, 18, 25	177,920
Puget silt loam	Washington 4, 5, 7	106,176
Salem silt loam	Oregon 5	78,656
Felida silt loam	Washington 7	61,696
Livermore silt loam	California 21	31,104
Tehama silt loam	California 16	29,888
Coquille silt loam	Oregon 3	26,816
Camas silt loam	Washington 7	10,496
Marysville silt loam	California 12	8,000
Feather silt loam	do	3,584
Elder silt loam	California 16	3,392
Maywood silt loam	do	2,368
Lauren silt loam	Washington 7	2,048
Pajaro silt loam	California 14	1,088
Total		543,232

[1] For key to numbers in this column see p. 733.

SILTY CLAY LOAM PHASE.

The silty clay loams are comparable with the soils of the silt loam group, in extent, range of climatic conditions, and other modifying factors. As a rule, they are somewhat less pervious and more compact in structure, tending to puddle when dry and bake and crack upon subsequent exposure to hot, dry weather. They are friable, however, and readily maintained in good tilth if worked under proper moisture conditions They are normally somewhat more retentive of moisture than the silt loams, and are rather more frequently poorly drained, and subject to overflow.

These soils do not differ greatly from the silt loams of the same series in crop adaptation They require a somewhat heavier farm equipment, and are adapted to a slightly heavier type of farming. Under favorable conditions of moisture, drainage, and tillage they are generally more favorable for forage crops and grains, and less so for vegetables, although practically all the products of the silt loams of the province are grown upon the silty clay loams in certain localities. The soils lack something of the wide capacity of the silt-loam group for growing a large number of crops successfully.

In the humid districts of Oregon and Washington, grain, clover. timothy, and forage crops are most extensively grown, with hops, potatoes, truck crops, and small fruits on the better-drained areas.

In the subhumid district of northern Oregon the type is represented by a single inextensive type not agriculturally important at present, but adapted to grains, alfalfa, vegetables, small fruits, apples, and pears.

In the interior California Valley the silty clay loams appear in a number of established soil series, and are devoted to the production of grains, sugar

beets, forage crops, alfalfa, prunes, pears, and vegetables, and locally to figs and peaches.

In the coastal valleys the silty clay loams have been encountered only to a limited extent, and are devoted mainly to grain, grain hay, and less extensively to sugar beets and alfalfa.

With the soils of the silt loam group, the silty clay loams constitute an extensive and important source of wealth in the River Flood Plains province in the development of its various forms of agricultural enterprise.

Chehalis silty clay loam.—The soil consists of a brown to reddish-brown silty clay loam from 10 to 15 inches deep. It is mellow and friable, and can be worked under a wide range of moisture conditions. The subsoil is a light-brown to reddish-brown, mellow silt loam to silty clay loam, extending to a depth of 3 feet. Below this depth the material in places becomes slightly lighter in color. As the type approaches the rivers it becomes lighter in texture. The type is generally level, though broken in places by abandoned stream channels. Except for a few wet depressions, the type is generally well drained. In its natural state it supports a heavy stand of fir, cedar, spruce, hemlock, alder, and vine maple, but at present much of it is cleared and under cultivation. This is one of the most valuable soils of the region, and well adapted to all of the small grains, hops, clover, various grasses, and fruits. Oats yield from 60 to 125 bushels per acre, wheat from 30 to 50 bushels, clover from 2 to 3 tons, and potatoes from 200 to 300 bushels per acre.

Coquille silty clay loam.—The soil consists of a bluish-gray to drab or grayish-brown silty clay loam, with an average depth of 18 inches. It is smooth, slightly micaceous, and of close, compact structure, puddling readily when wet, and checking upon exposure to dry weather. The organic-matter content is high, making the soil friable under favorable moisture conditions.

The subsoil consists of a bluish-gray or light-brown to drab silty clay loam of close, impervious, structure. The change from soil to subsoil is abrupt. The greater part of the area covered by the type is marked by a thin stratum of peat lying between the soil and subsoil. The type occupies bottom lands in the Coquille Valley and some minor tributary valleys. It has a flat and in many places a depressed surface. It is sometimes subject to overflow by streams or to submergence by high tides. Drainage is generally deficient, and the soil is waterlogged or swampy during the greater part of the year. It supports a dense growth of willow and tules and other rushes. Where cleared, it is devoted mainly to pasturage or to hay crops. Much of it is unreclaimed, but when drained and improved it should be well adapted to hay and forage crops, including timothy, alsike clover, vetch, kale, and grass crops.

Doty silty clay loam.—The soil consists of a light-brown to reddish-brown silty clay loam, having an average depth of 12 to 18 inches. Gravel and cobbles are often found scattered on the surface and mixed with the soil mass. The subsoil is a clay loam, clay, or silty clay. The type occupies benches or terraces from 8 to 25 feet above the present alluvial valleys along the larger streams. A small proportion of this type is overflowed at times by extremely high water.

Eld silty clay loam.—The soil consists of a reddish-brown to red, heavy silty clay loam, from 14 to 24 inches deep, containing a few iron concretions and a small quantity of gravel. The subsoil is a heavy silt loam or silty clay loam which, over the better drained portions of the type, is reddish-brown, mottled with gray. In poorly drained areas the gray color frequently predominates. The soil is loose and friable, and, except in the poorly drained places, is easily cultivated. Practically all of the type has been cleared. The type is adapted to hay and grain and the better-drained areas to potatoes, truck crops, and fruits. The chief crops grown are oats, hay, and potatoes.

Elder silty clay loam.—The type consists of a smooth, dark-gray silty clay loam, from 24 to 30 inches deep, and underlain by a compact, heavy loam in places containing water-worn gravel. This, in turn, at depths below 6 feet, is underlain by river sands and loam. The surface soil carries considerable organic matter. The type is dry-farmed to grains with excellent results. Under irrigation it is adapted to a wide range of general farm and fruit crops.

Gridley silty clay loam.—The type consists of a dark reddish brown sticky clay loam from 2 to 6 feet deep, becoming black in the subsoil over certain sections of the area. A gray calcareous hardpan is always present at depths ranging from 24 to 30 inches. The natural drainage is poor; the soil remains in a saturated condition throughout the rainy season. The type once supported a heavy growth of timber, some of which still remains. The greater portion is

now used for grain and pasture. Only a limited acreage is in other crops, but the soils seem adapted to such fruits as thrive on a heavy-textured soil.

Kelso silty clay loam.—The soil is a silty clay loam from 12 to 18 inches deep, and grayish brown to reddish brown in color, dry, cultivated fields assuming a grayish tinge. The subsoil consists of a brown, reddish-brown, or mottled compact silty clay loam. The entire type is uderlain by a deep deposit of gray, stratified silt, clay, and fine sand, 50 feet or more in depth, resting upon basaltic rock. Drainage is well established. Pockets or thin strata of coarse sand or gravel in places occur at varying depths and sometimes appear locally at the surface. The soil has good natural drainage, but the level topography, together with the compact structure of the subsoil, prevents excessive drainage and enables the soil to conserve moisture. It is adapted to potatoes, hay crops, small fruits, truck crops, and tree fruits.

Maywood silty clay loam.—The type consists of smooth ashy-gray silty clay loam 6 feet or more in depth, of compact structure, inclined to check upon exposure to dry weather. It is ordinarily free from coarse, sandy material or gravel. The soil is hard to handle unless received under proper moisture conditions. The surface is level to gently sloping and drainage rather poorly established. The type is devoted mainly to grazing and to the production of fruits, consisting of pears, figs, and peaches, and of alfalfa. Without irrigation yields are somewhat uncertain.

Merced silty clay loam.—The soil is dark brown to drab, readily puddled when wet, cracking upon subsequent exposure. The upper subsoil is of dark-brown to drab color, ranging from fine sandy loam to heavy clay loam, sometimes calcareous. It becomes lighter in color with depth. The material consists of flood-plain deposits, derived predominantly from granitic rocks. The topography is flat to slightly sloping and the surface frequently interrupted by sloughs or remnants of former stream channels. Alkali salts are often encountered in harmful amounts. The type is subject to overflow, poorly drained, and utilized mainly for grazing purposes. Where protected by levees and drained it is adapted to heavy vegetables, alfalfa, and the general farm crops.

Neal silty clay loam.—The soil is dark brown to nearly black and underlain by a brown to black heavy clay. The topography is level to slightly undulating, the type occupying gently sloping areas well situated for irrigation. Under favorable climatic conditions the type is adapted to grains, alfalfa, fruits, and vegetables.

Puget silty clay loam.—The soil consists of a gray to light-brown silty clay loam from 10 to 15 inches deep, containing a high proportion of organic matter. It is underlain by a gray silty clay loam or silty clay slightly marked with iron stains. Both soil and subsoil are frequently mottled with yellow, the mottling being more pronounced in the lower portion. The topography is level and the surface elevated only a few feet above the streams, making the type subject to overflow. Tile drains in many areas could be used to advantage. The chief crop grown on this soil is hay, which yields from 1½ to 3 tons per acre. Oats yield from 50 to 100 bushels. Cherries, apples, and other tree fruits do fairly well.

Sacramento silty clay loam.—This type is a dark-drab clay loam 6 feet in depth, containing a large amount of fine, micaceous, silty material, generally but not always free from gravel. It is normally of slightly compact structure, but is friable under cultivation. It is subject to overflow where not protected by levees and supports a fair growth of brush and forest trees. It is dry farmed to grains, and under irrigation is admirably adapted to alfalfa, sugar beets, forage and truck crops, and fruits.

Santa Rita silty clay loam.—The soil is a dark-gray to slate-colored silty clay loam from 2 to 3 feet deep, of friable structure, but sometimes having adobe tendencies. The subsoil is usually a lighter textured silty clay loam or silt loam of drab, brown, or slaty-gray color with blue and yellow mottlings. This material extends to a depth of 4½ to 5 feet. The mottling becomes more pronounced and the material heavier below 5 feet. Occasional pockets or thin strata of sandy loam occur. The surface is rather flat, with shallow depressions along old drainage channels. Drainage is poor, but has been improved by ditches. Alkali is sometimes found over small areas. The type is nearly all under cultivation and is mainly dry farmed to grain or hay or planted to sugar beets. Some well-drained areas are devoted to alfalfa.

Area and distribution of the silty clay loams.

Soil name.	State or area.[1]	Acres.
Chehalis silty clay loam	Washington 5, 7	151,296
Sacramento silty clay loam	California 2, 16, 25: Washington 7.	100,928
Merced silty clay loam	California 13	21,696
Doty silty clay loam	Washington 7	20,992
Kelso silty clay loam	do	14,080
Gridley silty clay loam	California 12	13,184
Coquille silty clay loam	Oregon 3	8,320
Eld silty clay loam	Washington 5	4,352
Neal silty clay loam	Oregon 4	1,984
Elder silty clay loam	California 16	1,600
Santa Rita silty clay loam	California 8	1,344
Puget silty clay loam	Washington 5	1,280
Maywood silty clay loam	California 16	384
Total		341,440

[1] For key to numbers in this column see p. 733.

Clay Loam Group.

The soils of the clay loam group are less extensive within the River Flood Plain province than the silt loams and silty clay loams.

As mapped, however, they are subject to wide variations in climate, drainage, character of substratum, adaptation to dry farming and irrigation, and other modifying factors affecting their development.

Under humid climatic conditions in western Washington, where the clay loam occurs in a single series, the soil is poorly drained and devoted to agriculture only on a limited scale. It is best adapted to grain and hay crops.

Under subhumid conditions in southern Oregon, where the group is represented by another single type, the soil is underlain by a pervious gravel substratum, and owing to this has some of the characteristics of the better-drained soils of lighter texture. Apples, pears, vegetables, small fruits, grain, and hay are the principal crops.

In the Interior Valley of California two clay loams occur, one of which is, however, of local development. The soils are often poorly drained, subject to overflow, and one of the types contains injurious accumulations of alkali. These soils are utilized principally for grazing and the production of grains without irrigation. Under favorable conditions of drainage and irrigation they are adapted to alfalfa, forage crops, and possibly to prunes and sugar beets.

In the coastal valley districts the clay loams are devoted mainly to grain and grain-hay production without irrigation. Stone fruits are grown to a small extent, but conditions of moisture supply and physical character of the soils are not favorable for these crops.

The soils of the clay loam group have a narrower range in adaptation to crops than those of the silt loam and silty clay loam groups.

Under favorable conditions of climate, irrigation, and drainage, and where well supplied with moisture naturally, they are admirably adapted to grains, hay, forage, and other general farm crops. Potatoes and heavy or late vegetables, pears, apples, and sugar beets would also probably find conditions favorable to development under suitable conditions of environment. None of the latter crops are grown extensively as yet.

Over poorly drained areas the soils are sticky and inclined to puddle when wet, becoming hard and baked when subsequently exposed to hot, dry weather. They require rather heavy farming equipment for careful and thorough cultivation, but under favorable conditions the soil may be maintained in a friable structure. They are adapted to general farming, dairying, stock raising, and the production of sugar beets, vegetables, and tree fruits. Of the fruits, pears, apples, and prunes are best suited to the prevailing soil conditions.

Chehalis clay loam.—The soil is of grayish-brown or drab to light-brown color and from 12 to 20 inches in depth. When dry the immediate surface often assumes a light-gray color. It is rather sticky and compact in structure but is generally friable under cultivation. The subsoil is a gray or mottled gray and yellow silty clay or silty clay loam. The soil is usually of lighter color and the

subsoil of heavier texture than the Chehalis silty clay loam. Drainage is deficient. The type is heavily forested and adapted to grains and grasses.

Livermore clay loam.—The soil is a very dark brown to nearly black clay loam 3 to 4 feet in depth. A small amount of gravel is sometimes present. The soil has a tendency to bake and check upon drying. The subsoil is a grayish or yellowish brown clay loam, somewhat lighter in texture than the soil in the upper part of the section but becoming heavier and more compact with depth. The topography is comparatively level, though the surface is interrupted by depressions of former stream channels. The type is well drained but retentive of moisture. It is devoted mainly to grain and grass with good results.

Marcuse clay loam.—The type consists of 24 to 36 inches of grayish clay loam, underlain by a sticky, reddish-brown loam. It is of sedimentary origin, representing material deposited by overflow waters, and is being added to with each annual inundation. The type is impregnated with alkali and is used only for grazing during the dry season. The natural drainage is very poor.

Salem clay loam.—The soil is a brown to dark-brown loam, of compact structure, and sticky when wet. The subsoil is a brown to dark-brown clay loam, underlain at depths of 18 inches to 6 or more feet by a substratum of compact, water-worn gravel. The surface is gently sloping and well adapted to irrigation. The type is of alluvial origin, derived mainly from basaltic material and occupies flood plains and stream terraces. Drainage is well established. The type is adapted to grains, alfalfa, pears, apples, vegetables, and small fruits.

Tassajero clay loam.—The soil to an average depth of 3 feet consists of a dark-brown, light-textured clay loam, showing mottlings of gray and brown when wet and becoming lighter in color at 2 feet. The dry cultivated surface is of reddish-brown color. In places the material approaches an adobe in structure. The subsoil is a lighter colored clay loam or sandy clay loam, merging into a faintly mottled, heavy, nearly black loam at 4½ to 5 feet. The type is gently sloping and generally well drained It is derived from material washed from areas of sandstone and shale. It is entirely under cultivation and devoted chiefly to grain and hay. Some peaches, prunes, and apricots are grown, but the fruit is of inferior size, owing to lack of moisture.

Vina clay loam.—The soil is a light-brown to dark chocolate brown, smooth-textured clay loam from 2 to 6 feet deep.

It is sticky when wet, puddles readily, and cracks slightly upon subsequent exposure. It is underlain at depths below 24 inches by a slightly lighter-colored clay loam or heavy loam, which in turn rests upon andesitic conglomerate or tuff of the Tuscan series. The type is important, though not of great extent. The topography varies from nearly level to gently sloping, and the surface drainage is somewhat restricted and in occasional shallow depressions rather deficient. Overflows by flood waters of intermittent streams occur in some places. The type supports growths of valley oak, brush, and wild grasses. It is devoted principally to dry-farmed grain, but is better adapted to intensive agriculture under irrigation than to alfalfa, stone fruits, and general farm crops.

Area and distribution of the clay loams.

Soil name.	State or area.[1]	Acres.
Chehalis clay loam	Washington 7	34,560
Marcuse clay loam	California 12	14,592
Vina clay loam	California 16	6,848
Salem clay loam	Oregon 4	4,736
Tassajero clay loam	California 8	832
Livermore clay loam	do	576
Total		62,144

[1] For key to numbers in this column see p. 733.

GRAVELLY CLAY LOAM PHASE.

Gravelly clay loam soils are of unusual occurrence in the River Flood Plain province, and have been encountered only in one area, where they are represented by a single type. This occupies stream terraces, lying well above present flood plains, and is underlain by a porous, gravelly substratum.

Owing to its position, the pervious character of underlying material, and to the gravel content, drainage is excessive, and the soil deficient in power to retain moisture, and droughty, although occurring under conditions of moderately heavy rainfall. These factors are of sufficient influence to cause the gravelly clay loam phase to depart widely from the characteristics of the soils of the clay loam group. In adaptation to crops it resembles the gravelly loams, being less well adapted to general farm crops than the clay loams. Under irrigation and intensive cultivation it is suited to prunes, apples, and the lighter vegetables.

Nasel gravelly clay loam.—The soil is a dark-brown to black clay loam, carrying small quantities of cobbles and gravel on the surface, and frequently intermingled with the soil. This is underlain at a depth of 12 to 18 inches by a mass of water-worn gravel and cobbles, with a small quantity of interstitial sand and finer material of a yellowish color. On the slopes the surface soil is particularly gravelly and stony. The slopes toward the stream are frequently steep and abrupt, and of stony character, but the tops of the terraces are level to gently undulating. The type is deficient in moisture-retaining capacity. Under irrigation it can be utilized for fruit and vegetables.

Area and distribution of the gravelly clay loam.

Soil name.	State or area.[1]	Acres.
Nasel gravelly clay loam	Washington 7	6,656

[1] For key to number in this column see p. 733.

CLAY LOAM ADOBE PHASE.

The clay loam adobe soils of this province, while found in extensive bodies, are comparatively rare, and so far have been mapped only in the subhumid and semiarid coastal valleys of California.

The adobe characteristics of structure are highly developed, the soils being exceedingly sticky when wet, and baking and checking to a marked extent upon drying. Under unfavorable conditions of moisture and structure they are exceedingly difficult to handle. Under favorable conditions and with efficient methods of cultivation, they assume a friable condition, and are unusually retentive of moisture and productive.

Grains consisting of wheat, oats, and barley are most widely grown, and under irrigation the culture of sugar beets upon an extensive scale has been highly developed. In well-drained areas, alfalfa, apples, potatoes, beans, strawberries, and bramble fruits are grown with excellent results.

Under favorable conditions of drainage and structure the clay loam adobes of the province are adapted to much the same general farm crops as the soils of the clay loam group, and under careful management and intensive cultivation are better adapted to dry-farmed crops and generally somewhat more favorable for the culture of small fruits and vegetables. They require careful management and a heavy farming equipment for efficient utilization.

Pajaro clay loam adobe.—This type consists of a plastic black clay loam of varying depths to 3 feet, cracking when dry into small adobe cubes. It is underlain by compact, tenacious, and slightly pervious yellow clay loam or silty clay loam. The soil differs from the adobes of the Stockton series in the absence of a thin, marly, hardpan-like layer between the soil and subsoil. It contains large quantities of lime and humus and is fairly easy to cultivate if tilled at the proper time, but if too dry it breaks up into large clods. On account of poor natural drainage it is often covered with water during the wet seasons, with consequent damage to orchards and growing crops. It is an excellent berry soil.

Salinas clay loam adobe.—The soil is of dark-gray to black color and of refractory, compact structure, becoming sticky when wet and baking upon exposure. When in a favorable moisture condition it is friable under cultivation. The subsoil is similar in color, texture, and structure to the soil material and is underlain by a substratum of light-gray fine sandy loam or fine porous sand at depths ranging from 30 inches to 3 feet. The type is of alluvial origin, the material of which it is composed being derived from crystalline and metamorphic rocks, with some shale and sandstone. It occupies terraces in river valleys of gentle slope and is usually free from overflow. Subdrainage is somewhat restricted owing to the heavy, impervious character of the soil and subsoil. The soil is retentive of moisture under proper cultivation and is adapted to grains and, under irrigation, to sugar beets.

Area and distribution of the clay loam adobes.

Soil name.	State or area.[1]	Acres.
Salinas clay loam adobe	California 10	18,400
Pajaro clay loam adobe	California 14	4,800
Total		23,200

[1] For key to numbers in this column see p. 733.

CLAY GROUP.

The soils of the clay group in the areas mapped in this province are of moderately frequent and extensive occurrence. They are less widely distributed than the members of the groups of somewhat lighter texture.

Climatic, drainage, and other modifying conditions vary widely, but the soils are commonly subject to poorly developed surface or subsurface drainage and in some places to periodical overflow where not protected by levees. In the more arid districts a tendency toward an adobe structure is frequently developed, the soils of the group puddling readily under inefficient management or unfavorable conditions of drainage. They require heavy farming equipment and thorough culture to maintain a condition of tilth favorable to the conservation of moisture and the growth of crops.

In the humid districts they are poorly drained and frequently subject to overflow, and are utilized mainly for the production of oats, clover, other hay crops, and dairy products.

In the subhumid districts in southern Oregon the group is represented by a single type, characterized by an impervious hardpan substratum, and much of the area is suitable only for the production of shallow-rooted crops. The deeper areas, or areas improved by blasting, are adapted to the production of apples, pears, and small fruits suitable to soils of heavy texture.

In the semiarid portions of California clay soils have been recognized in three important series found in the interior and coastal valleys. They are utilized mainly for pasture and for the production of grain and grain hay without irrigation. The better drained areas of friable structure are adapted to the production of sorghum and other forage crops, timothy, rye grass, and other grasses, and alfalfa and root crops. Tree and small fruits and vegetables are successfully grown in exceptional locations, but the soils of the group are not generally adapted to these products.

As a unit the soils of the clay group are adapted to the production of hay and dairy products, and under favorable conditions of drainage and tillage to grains and forage crops. Sugar beets and other intensively cultivated products will succeed under favorable conditions, but usually find more suitable conditions on the soils of somewhat lighter texture.

Antelope clay.—The type consists of a grayish-brown to black sticky clay from 6 inches to 4 feet deep, sometimes carrying a small quantity of waterworn gravel, and underlain by a thin layer of iron hardpan and brown to yellowish-brown beds of cemented water-worn gravel and sand. The underlying cemented material is similar to that found beneath the Agate series, but the surface material has probably been modified by an admixture of alluvium washed from higher levels. The topography is slightly sloping and the surface in places marked by "hog wallows." Under irrigation the deeper areas are

suitable for the production of apples, pears, and small fruits. Much of the type, however is shallow and unsuitable for the culture of deep-rooted crops, although such areas may be improved by blasting the hardpan.

Chehalis clay.—The soil consists of 10 to 12 inches of a dark-colored, heavy, tenacious clay mottled with yellow and orange. When dry the surface varies from dark gray to slate colored, but when wet it is decidedly black. In the latter condition it is sticky and compact and on drying becomes sun-cracked, hard, and difficult to handle. The lower lying areas carry considerable organic matter. Small bodies of a lighter colored phase have been included with this type.

The subsoil from 12 to 36 inches usually consists of mottled gray and orange waxy clay overlying a gray clay of compact structure, although in places it is dark drab to slate color, with slight reddish-brown iron stains. The type is uniformly level, is often flooded and in most cases is poorly drained. It was originally heavily forested with fir, cedar, vine maple, alder, and underbrush, but at present nearly all of it is under cultivation. It is well adapted to the production of hay and grain crops. Yields of from 60 to 100 bushels of oats and about 2½ tons of clover hay per acre are secured.

Livermore clay.—The soil is a compact, dark chocolate brown to dark-gray clay carrying small amounts of gravel, the upper 6 inches of soil being somewhat lighter in texture than the underlying material. The subsoil is a lighter brown to brown clay loam encountered at depths of 2½ to 3½ feet, lighter in texture and more silty than the soil, but in places grading into more compact clay loam between 5 and 6 feet. It is comparatively flat, with some slight depressions, and well drained except in the lower-lying bodies, which are overflowed for short periods. The type is generally treeless except for a few valley oaks. It is utilized mainly for hay and grain, with good yields, and under irrigation is suitable for alfalfa and fruits.

Sacramento clay.—The soil is a dark-brown to nearly black clay, from 18 to 30 inches deep, containing much organic matter, underlain by a buff-colored fine sandy loam and silt loam. It is free from gravel and has a dense, adobelike structure. The type is formed by the mixing of fine river sediments with well-decomposed peaty and other organic matter. It covers extensive areas of level swamp and overflow lands of stream deltas, and grades insensibly into adjacent peat and adobe lands. It supports a heavy growth of willows, tules, or other swamp vegetation. The soil is very productive when drained and protected from tidal or flood waters. Grains, grain hay, timothy, and other grasses, potatoes, onions, beans, etc., are the principal crops.

Tehama clay.—The type consists of a compact, light grayish brown to yellowish-brown clay, from 36 to 48 inches deep, sticky when wet and becoming hard and impervious and checking upon subsequent exposure. It is hard to handle except under proper moisture conditions. Drainage is poor. The type occurs as elongated or depressed bodies of inextensive area. The topography is gently sloping to level. The land is largely utilized, or is devoted only to dry farming to grain. With careful management, under irrigation, it could possibly be used for other crops.

Area and distribution of the clays.

Soil name.	State or area.[1]	Acres.
Sacramento clay	California 12, 23, 25	212,928
Chehalis clay	Washington 5, 7	5,120
Livermore clay	California 8	2,432
Antelope clay	Oregon 4	1,792
Tehama clay	California 16	1,536
Total		223,808

[1] For key to numbers in this column see p. 733.

SILTY CLAY PHASE.

The silty clays have been mapped most extensively in the humid regions of western Washington, where they have been recognized in three soil series. Other areas included in two distinct soil series occur in the subhumid and arid coastal districts and interior valley of California, along streams heading in the adjacent mountains and traversing regions of comparatively heavy rainfall and subject to erosion.

The soils occupy low-lying positions, and much of the areas covered are subject to overflow and poorly drained. In this present condition they are adapted only to grazing.

Where capable of utilization, they are, in the humid districts, adapted to clover, timothy, dairying, and to late bramble fruits and vegetables.

In the more southern areas of limited rainfall they are utilized for pasture and for the production of wheat and barley without irrigation, and, to some extent, sugar beets. The better drained areas are well adapted to this crop, as well as to sorghum and other forage crops.

The silty clay loams become very sticky when wet and bake and check upon subsequent exposure during hot, dry periods. They require careful management in cultivation and irrigation, and are with some difficulty maintained in a favorable condition of structure. They are, however, of more friable structure than the soils of the clay group of this province and are, under favorable drainage and cultural conditions, better adapted to small fruits, vegetables, most of the forage crops, and to sugar beets.

A heavy farming equipment is essential for their economical utilization. In adaptation to the various types of farming they occupy a position intermediate between the silty clay loams and the clays.

Chehalis silty clay.—The soil consists of a brownish-gray to bluish-gray heavy silty clay, about 12 inches deep, mottled with yellow and carrying a high percentage of organic matter. The subsoil is a bluish-gray to slate-colored silty clay, also frequently mottled with yellow and lighter shades of gray. Brown iron stains are common in both soil and subsoil and layers of peat and muck are frequently encountered throughout the type. The material is derived from finer deposits of silt and clay brought down and deposited in quiet waters at the mouth of streams. The topography is level, the greater part of the type being very little above high tide. It is intersected by a number of small brackish sloughs. During the winter much of it is inundated, while at all times the water table is so near the surface as to necessitate drainage before crops can be successfully grown. When this has been done the soil should be well adapted to truck crops, especially celery and cabbage.

Nasel silty clay.—The soil is a silty clay with a depth of 16 to 24 inches. In a few cases a small quantity of basaltic gravel is found on the surface and mixed with the soil. It contains a large quantity of organic matter and is of somewhat compact structure, checking when dry, but is friable under cultivation. The subsoil consists of a mottled, light-brown, yellow, or gray clay loam or clay underlain at a depth of 3 feet or more by a substratum of water-laid gravel and cobbles. The surface soil contains a considerable amount of decomposed organic matter. Owing to the impervious subsoil and level topography the natural drainage of this type is poor. The soil is not at present subject to overflow except under unusual conditions of flood. It is rather droughty in seasons of deficient rainfall.

Pajaro silty clay.—The type consists of a light-yellow or drab plastic silty clay varying from 12 to 36 inches in depth, overlying a dark loam or silt loam which previously formed the top soil. This material has been derived from recently weathered shales carried down by the Pajaro River and deposited during flood seasons in depressions or low channels near the river. When first deposited this soil cracks into large blocks, the cracks extending to the underlying lighter soil. In time the surface soil, through weathering and cultivation, becomes less refractory, and is used for barley, sugar beets, and other crops.

Puget silty clay.—This soil consists of from 10 to 15 inches of a drab to slightly mottled silty clay carrying a large amount of organic matter in various stages of decomposition. The subsoil is a heavy silty loam or silty clay, slightly mottled with iron stains. The subsoil is quite similar in texture to the soil, but contains a smaller quantity of organic matter. The topography is nearly level, many of the larger areas being only slightly elevated above the level of the stream channels or above tide. Its low topographic position causes many of the areas to be overflowed at times of high water, and it is often necessary to dike the land near the mouths of the rivers. The type as a whole has very poor natural drainage, and artificial drainage is usually necessary. The type is derived from the finer sediments of silt and clay deposited in quiet waters at times of overflow or deposited in the shallow waters at the mouths of the rivers, eventually building up delta "flats." When thoroughly drained the soil is very productive. Oats is the principal crop grown and very large yields are obtained. Wheat also gives very large yields. Clover, timothy, small fruits, and vegetables are grown on this type with good results.

Sacramento silty clay.—The type consists of a dark-gray to nearly black silty clay, usually free from gravel and 6 feet or more in depth. It is of compact structure, baking and checking during the dry season, but friable under cultivation if handled in a favorable condition as regards moisture. It occurs as inextensive bodies occupying depressions in river flood plains, is generally more or less subject to overflow, and is at present devoted to dry farming and grazing. The more elevated and better drained bodies should, however, under irrigation, be capable of profitable production of alfalfa, sugar beets, sorghum, and other forage crops.

Area and distribution of the silty clays.

Soil name.	State or area.[1]	Acres.
Puget silty clay	Washington 4, 5	83,968
Chehalis silty clay	Washington 5, 7	54,528
Sacramento silty clay	California 2, 25	32,576
Nasel silty clay	Washington 7	15,872
Pajaro silty clay	California 14	640
Total		187,584

[1] For key to numbers in this column see p. 733.

CLAY ADOBE PHASE.

A pronounced clay adobe structure is of frequent occurrence in the soils of clay texture in those portions of the River Flood Plain province occurring within the semiarid and subhumid districts of Oregon and California. The soils are of rather more extensive occurrence and more widely distributed in these districts than are the normal clays.

They are subject to considerable variation in local climatic conditions, drainage, character of underlying material, and in relation to irrigation and other factors influencing their adaptation to crops. Some of the higher lying bodies are well drained and favorably situated for irrigation, while others occupy low-lying positions subject to overflow, are poorly drained and in places impregnated with alkali.

The adobe characteristics of structure are usually highly developed and exert much the same influence upon physical character, cultural operations, and crop adaptation as with the clay loam adobes. The soils when wet are exceedingly tenacious, bake, check, and crack extensively during hot, dry periods, and require the heaviest of farming equipment. When in a favorable moisture condition, however, they are friable, and when deeply plowed and thoroughly tilled, or when favored by granulated structure, sometimes acquired under natural conditions, are unusually retentive of moisture through protracted periods of drought.

Under suitable conditions of drainage and moisture supply, tillage, etc., they are adapted to a heavy type of general farming. They are not usually adapted to vegetables, or to fruits, except pears, which are very successfully grown where local conditions are favorable. In the coastal valley districts in California extensive areas of the clay adobe soils are profitably devoted to the production of sugar beets, grown mainly by aid of irrigation. With careful irrigation and thorough tillage the production of this crop can probably be successfully extended in both the coastal valley and interior valley districts.

Antelope clay adobe.—The type is a dark-brown to black clay adobe, with brown to dark-brown subsoils underlain by a substratum of compact, cemented, gravels separated from the overlying material by a thin layer of iron hardpan at a depth varying from 1 to 6 feet or more. The soil is of dense, refractory, adobe structure, becoming very adhesive when wet and baking and checking upon exposure to dry weather. The position of the type usually favors irrigation, and many of the areas covered are adapted to pears and small fruits. The shallow phases are suitable for deep-rooted crops only after blasting.

Neal clay adobe.—The soil is a compact, refractory, black clay adobe. The subsoil is a compact clay usually becoming lighter in color below 3 feet, but the parent shale rock may sometimes directly underlie the dark-colored soil material. Gravel is rarely present. The type is subject to occasional overflow, and has a slightly sloping topography. It is adapted to grains, hay crops,

and under favorable climatic conditions, to pears. Drainage is poorly established.

Sacramento clay adobe.—The soil is a gray or grayish-black clay of adobe structure, with an average depth of from 24 to 36 inches. The subsoil is a dark-brown clay which usually becomes yellowish brown in color with increasing depth. It occupies a low position and is subject to overflow at times of flood. The surface is level and natural drainage is usually deficient. Alkali is often present in sufficient quantities to be injurious to shallow-rooted crops. The native vegetation consists chiefly of alkali weeds and wild grasses. Grain is profitably grown on limited areas protected from overflow.

Salem clay adobe.—The soil is a black clay of heavy, refractory, adobe structure, sticky when wet and checking upon subsequent exposure. The subsoil is similar in color, texture, and structure, and is underlain by a substratum of waterworn gravels, in places cemented. The underlying gravels do not usually occur within the depth of 6 feet. The soil often contains a large quantity of organic matter and is poorly drained. The topography varies from smooth to uneven. The type is of alluvial origin, the material being derived from basaltic rocks, and occupies stream flood plains and terraces usually free from overflow. It is adapted to alfalfa and to pears under favorable drainage conditions.

Salinas clay adobe.—The soil is dark gray to black, with a clay texture and compact adobe structure. It becomes very tenacious when wet and bakes and checks upon exposure. It is tilled with difficulty, but under proper management becomes fairly friable. The subsoil is similar to the soil material but is underlain at a depth of about 30 inches by fine sand or fine sandy loam of light-gray color. The type is of alluvial origin derived mainly from materials washed from metamorphic and sedimentary rocks. It occupies low, level, or depressed areas in river flood plains and terraces. Under favorable conditions of drainage, irrigation, and cultivation the type is adapted to dry-farmed grains and sugar beets.

Santa Rita clay adobe.—The soil is a dark-gray or slate-colored sticky clay adobe carrying much silt and little sand. It is frequently mottled with bluish gray, brown, and yellow in the lower portion, pockets of fine sand and silty fine sand being of occasional occurrence. The soil is in places 6 feet or more in depth, but the subsoil is usually encountered at 3 to 5 feet. It consists of rather compact layers of slaty, heavy, black clay. The soil cracks and checks upon exposure, forming a friable surface structure and is easily cultivated. The surface is generally flat or gently sloping. Natural drainage is restricted but has been improved by ditching. Considerable areas of alkali occur but the salts are mainly concentrated in the subsoils under which conditions hay and grains are grown. Tules and willows are found on undrained areas. Most of the type is under cultivation and devoted mainly to hay and grains, and limited areas to sugar beets.

Vina clay adobe.—The Vina clay adobe is of dark-gray to nearly black color and consists of a heavy, compact clay of pronounced adobe structure. It is readily puddled and becomes very tenacious when wet, and upon subsequent exposure assumes an extremely hard condition and becomes checked with fragments of various sizes. The type is marked by small, intermittent, poo defined drainage courses in the vicinity of which accumulations of and bowlders and cobbles are often found. The soil is underlain to 4 feet an indurated mass of andesitic gravel and tufaceous material similar that underlying the Tuscan series, although a deeper phase is found a mewhat lower elevations in the vincinity of the valley bottoms. The gen surface is of sloping character and of fair drainage. The type is gener treeless, except in the vicinity of stream channels traversing lower l bodies. It is utilized principally for the production of grain without ir ation or for grazing purposes. Owing to the usual shallow character, it ess well adapted to irrigation and to the production of deep-rooted crops th are most of the other members of the Vina series.

Area and distribution of the clay adobes.

Soil name.	State or area.[1]	Acres.
Sacramento clay adobe	California 25	29,952
Salinas clay adobe	California 10	11,580
Vina clay adobe	California 16	4,928
Salem clay adobe	Oregon 4	4,352
Santa Rita clay adobe	California 8	3,456
Antelope clay adobe	Oregon 4	2,432
Neal clay adobe	do	1,280
Total		57,980

[1] For key to numbers in this column see p. 733.

MISCELLANEOUS MATERIAL.

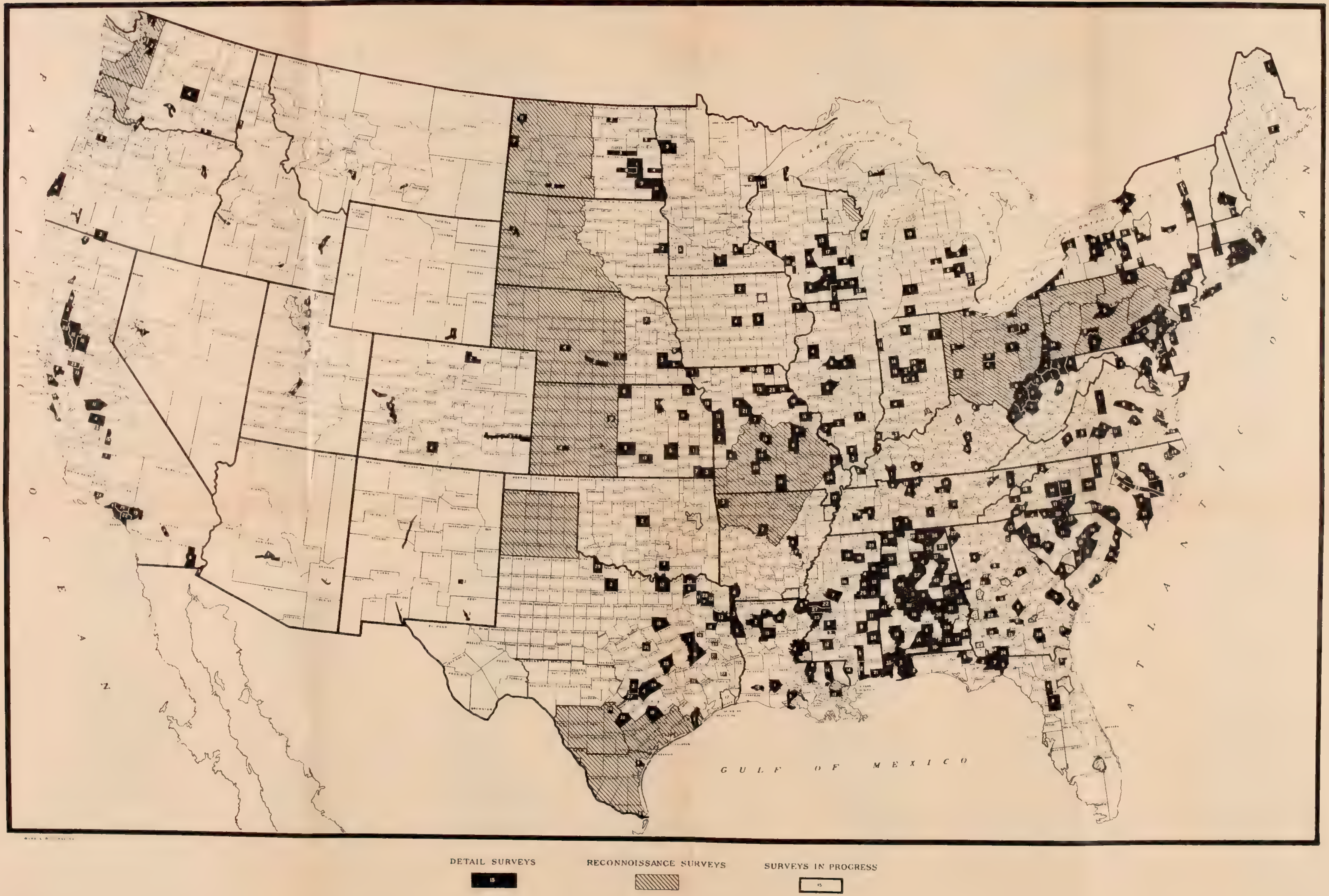
Area and distribution of the miscellaneous material.

Soil name.	State or area.[1]	Acres.
Rough mountainous land	Oregon 3	220,160
Rough stony land	California 2, 11, 12, 15, 16, 17, 18; Washington 7; Oregon 4	196,735
Dunesand	California 5, 6, 9, 14, 24; Oregon 3; Washington 5	147,492
Riverwash	California 1, 2, 3, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 21, 24, 25; Oregon 4.	124,418
Peat	California 9, 14, 19, 22, 23; Oregon 3	115,027
Muck and peat	Washington 4, 5, 7	80,512
Tidal marsh	California 9, 14, 21; Oregon 3; Washington 4, 5	43,520
Coastal beach and dunesand	Washington 7	7,168
Meadow	California 3	5,478
Coastal beach	Washington 4, 5	4,352
Swamp	Washington 4	2,240
Rock outcrop	do	512
Total		947,614

[1] For key to numbers in this column see p. 733.

BUREAU OF SOILS
UNITED STATES DEPARTMENT OF AGRICULTURE

PROGRESS OF SOIL SURVEY WORK



KEY TO AREAS SHOWN ON PROGRESS MAP—JANUARY 1, 1913.

ALABAMA.

1 Autauga County
2 Baldwin County
3 Bibb County
4 Blount County
5 Bullock County
6 Butler County
7 Calhoun County
8 Chambers County
9 Chilton County
10. Clarke County
11 Clay County.
12 Coffee County
13 Colbert County
14 Conecuh County
15 Covington County
16 Cullman County
17 Dale County
18 Dallas County.
19 Elmore County
20 Escambia County.
21 Etowah County
22 Fort Payne area.
23 Hale County
24 Henry County
25 Huntsville area
26. Jackson County.
27 Jefferson County.
28 Lamar County
29 Lauderdale County.
30 Lee County
31 Macon County.
32 Madison County.
33 Marion County.
34 Marshall County.
35 Mobile County
36 Montgomery County.
37 Perry County.
38 Pike County
39 Randolph County.
40 Russell County
41. Sumter County.
42 Talladega County
43 Tallapoosa County.
44 Tuscaloosa County.

ARIZONA.

1 Salt River Valley.
2 Solomonsville area.
3 Yuma area.

ARKANSAS.

1 Ashley County
2 Conway County
3 Fayetteville area
4 Miller County
5 Mississippi County
6 Prairie County.
7 Stuttgart area.

CALIFORNIA.

1 Bakersfield area
2 Butte Valley area.
3 Colusa area.
4 Fresno area
5 Hanford area
6 Imperial area
7 Indio area
8 Livermore Valley
9 Los Angeles area
10 Lower Salinas Valley
11 Madera area
12 Marysville area
13 Modesto Turlock area
14 Pajaro Valley area
15 Portersville area
16 Redbluff area
17 Redding area
18 Sacramento area
19 San Bernardino area
20 San Gabriel area
21 San Jose area
22 Santa Ana area
23 Stockton area.
24 Ventura area
25. Woodland area.

COLORADO.

1. Grand Junction area.
2 Greeley area
3 Lower Arkansas Valley.
4 San Luis Valley
5 Uncompahgre Valley area

CONNECTICUT.

1 Connecticut Valley.
2 New London County.
3 Windham County.

DELAWARE.

1 Dover area.

FLORIDA.

1 East Central Coast area
2 Escambia County.
3 Gadsden County.
4 Gainesville area.
5 Jacksonville area
6 Jefferson County
7 Leon County
8 Marianna area
9 Ocala area.
10 Palmetto area.
11 Pinellas County
12 Putnam County.

GEORGIA.

1 Bainbridge area.
2 Ben Hill County
3 Bulloch County.
4 Chatham County
5 Chattooga County
6 Cobb County
7 Columbia County.
8 Covington area
9 Dodge County.
10 Dougherty County.
11 Fort Valley area.
12 Franklin County.
13 Glynn County.
14 Grady County.
15 Hancock County.
16 Jeff Davis County.
17 Jones County.
18 Miller County.
19 Pike County.
20 Spalding County.
21. Stewart County
22. Sumter County.
23 Talbot County.
24 Thomas County.
25 Tift County
26 Troup County.
27. Walker County
28. Waycross area.

IDAHO.

1 Blackfoot area
2. Boise area
3. Lewiston area.
4 Minidoka area

ILLINOIS.

1 Clay County.
2 Clinton County
3 Johnson County
4. Knox County.
5 McLean County
6 Sangamon County
7 St. Clair County
8 Tazewell County
9 Will County
10 Winnebago County.

INDIANA.

1 Allen County.
2 Boone County
3. Boonville area
4 Greene County
5. Hamilton County
6. Hendricks County.

INDIANA—Continued

7. Madison County.
8. Marion County.
9 Marshall County.
10 Montgomery County.
11 Newton County.
12 Posey County.
13 Scott County.
14 Tippecanoe County.
15 Tipton County.

IOWA.

1 Bremer County
2 Cerro Gordo County.
3 Dubuque area
4 Story County
5 Tama County.

KANSAS.

1 Allen County.
2 Brown County.
3 Cherokee County.
4 Garden City area
5. Greenwood County.
6 Jewell County.
7. Parsons area.
8 Reno County.
9. Riley County.
10 Russell area.
11 Shawnee County.
12. Wichita area.

KENTUCKY.

1 Christian County.
2 McCracken County.
3 Madison County.
4 Mason County.
5 Rockcastle County.
6 Scott County.
7. Union County.
8 Warren County.

LOUISIANA.

1. Acadia Parish.
2. Bienville Parish.
3 Caddo Parish
4 Concordia Parish.
5. De Soto Parish.
6. E. and W. Carroll Parishes.
7. East Baton Rouge Parish.
8. East Feliciana Parish.
9. Iberia Parish
10. Lake Charles area.
11 Lincoln Parish.
12. New Orleans area.
13 Ouachita area
14 Tangipahoa Parish.
15. Winn Parish.

MAINE.

1. Caribou area.
2 Orono area

MARYLAND.

1. Anne Arundel County.
2 Calvert County.
3. Cecil County.
4 Easton area.
5 Harford County.
6 Kent County.
7. Prince George County.
8. St. Mary County.
9. Worcester County.

MASSACHUSETTS.

1 Connecticut Valley
2 Plymouth County.

MICHIGAN.

1 Allegan County.
2 Alma area
3 Cass County
4 Genesee County.
5. Munising area.
6. Owosso area.

MICHIGAN—Continued.

7. Oxford area.
8 Pontiac area.
9 Saginaw area.
10. Wexford County.

MINNESOTA.

1 Blue Earth County.
2 Carlton area.
3 Crookston area.
4. Goodhue County.
5. Marshall area.
6 Rice County.

MISSISSIPPI.

1. Adams County.
2. Biloxi area.
3. Clarke County.
4. Clay County.
5. Crystal Springs area.
6. Forrest County.
7. Holmes County.
8. Jackson area.
9 Jasper County.
10. Lafayette County.
11 Lauderdale County.
12 Lincoln County.
13. Lowndes County.
14. McNeill area.
15 Monroe County.
16. Montgomery County.
17. Noxubee County.
18. Oktibbeha County.
19. Pontotoc County.
20 Prentiss County.
21. Scranton area.
22 Smedes area.
23 Warren County.
24 Wayne County.
25. Wilkinson County.
26. Winston County.
27. Yazoo area.

MISSOURI.

1. Atchison County.
2. Bates County.
3. Cape Girardeau County.
4. Carroll County
5. Cass County.
6 Cedar County.
7. Cooper County.
8. Crawford County.
9. Franklin County.
10 Howell County.
11. Jackson County.
12 Laclede County.
13 Macon County.
14. Marion County.
15 Miller County.
16 O'Fallon area.
17. Pemiscot County.
18. Pike County.
19 Platte County.
20 Putnam County.
21 Saline County.
22. Scotland County.
23 Shelby County.
24 Stoddard County.
25. Webster County.

MONTANA.

1. Billings area.
2 Gallatin Valley area.

NEBRASKA.

1 Grand Island area.
2. Kearney area.
3 Lancaster County.
4 North Platte area.
5. Otoe County.
6 Sarpy County.
7 Stanton area.

NEVADA.

1 Fallon area.

NEW HAMPSHIRE.

1. Merrimack County.
2. Nashua area.

NEW JERSEY.

1. Freehold area.
2. Salem area.
3. Sussex area.
4. Trenton area.

NEW MEXICO.

1. Albuquerque area.
2 Mesilla Valley area.
3. Pecos Valley.

NEW YORK.

1. Auburn area.
2. Bigflats area.
3 Binghamton area.
4. Dutchess County.
5. Jefferson County.
6 Livingston County.
7. Long Island area.
8. Lyons area.
9 Madison County.
10. Monroe County.
11. Montgomery County.
12 Niagara County.
13 Oneida County.
14. Ontario County.
15 Orange County.
16 Syracuse area.
17. Tompkins County
18. Washington County.
19. Westfield area.

NORTH CAROLINA.

1. Alamance County.
2. Ashe County.
3. Asheville area.
4 Cabarrus County.
5. Cary area.
6. Caswell County.
7. Chowan County.
8. Craven area.
9. Duplin County.
10. Edgecombe County.
11. Gaston County.
12. Granville County.
13. Henderson County.
14. Hickory area.
15. Johnston County.
16. Lake Mattamuskeet area.
17. Mecklenburg County.
18. Mount Mitchell area.
19 New Hanover County.
20. Pasquotank and Perquimans Counties.
21. Pender County.
22 Pitt County.
23. Raleigh to Newbern area.
24. Randolph County.
25 Richmond County.
26. Robeson County.
27. Scotland County.
28. Statesville area.
29 Transylvania County.
30 Wake County.

NORTH DAKOTA.

1. Barnes County.
2 Cando area.
3. Carrington area.
4. Fargo area.
5. Grand Forks area.
6. Jamestown area.
7. McKenzie area.
8. Morton area.
9 Ransom County.
10. Richland County.
11. Williston area.

OHIO.

1 Ashtabula area.
2. Auglaize County.
3. Cleveland area.
4 Columbus area.
5 Coshocton County.
6 Meigs County.
7. Montgomery County.
8. Stark County.
9. Toledo area.
10. Westerville area.
11. Wooster area.

OKLAHOMA.

1. Muskogee County.
2. Oklahoma County.
3. Tishomingo area.

OREGON.

1. Baker City area.
2. Hood River area.
3 Klamath Reclamation Project area.
4. Medford area.
5 Polk County.
6. Salem area.

PENNSYLVANIA.

1. Adams County
2. Bedford County.
3. Berks County.
4. Bradford County.
5. Center County.
6. Chester County.
7. Erie County.
8 Johnstown area.
9. Lancaster area.
10. Lebanon area
11. Lehigh County
12 Lock Haven area
13. Montgomery County.
14. Washington County.
15. York County.

RHODE ISLAND.

1. Entire State.

SOUTH CAROLINA.

0. Abbeville area.
1. Anderson County.
2. Bamberg County.
3. Barnwell County.
4. Campobello area.
5. Charleston area.
6. Cherokee County.
7. Chester County.
8 Clarendon County.
9. Conway area.
10. Darlington area.
11. Fairfield County.
12. Georgetown County.
13. Lancaster County.
14. Lee County
15. Oconee County.
16. Orangeburg area.
17 Orangeburg County.
18. Saluda County.
19 Sumter County.
20 York County.

SOUTH DAKOTA.

1. Belle Fourche area.
2 Brookings area.

TENNESSEE.

1. Coffee County.
2. Davidson County.
3. Giles County.
4. Grainger County.
5. Greeneville area.
6. Henderson County.
7. Lawrence County.
8. Madison County.
9. Montgomery County.
10. Overton County.
11. Pikeville area.
12 Putnam County.
13. Robertson County.
14 Sumner County.

TEXAS.

1. Anderson County.
2. Archer County.
3 Austin area.
4. Bastrop County.
5. Brazoria area.
6. Brownsville area.
7 Camp County.
8. Cooper area.
9. Corpus Christi area.
10. Ellis County.
11. Franklin County.
12. Grayson County.
13. Harrison County.

TEXAS—Continued.

14. Henderson area.
15 Houston County.
16. Jacksonville area.
17 Jefferson County
18. Laredo area.
19. Lavaca County
20 Lee County.
21 Lufkin area
22 Morris County.
23 Nacogdoches area.
24. Paris area.
25. Robertson County.
26 San Antonio area.
27. San Marcos area.
28 Titus County.
29 Vernon area
30 Waco area
31. Willis area.
32 Wilson County.
33. Woodville area.

UTAH.

1. Bear River area
2. Cache Valley area
3. Provo area
4 Salt Lake Valley
5 Sevier Valley.
6 Weber County area.

VERMONT.

1. Vergennes area.

VIRGINIA.

1. Albemarle area.
2. Appomattox County.
3. Bedford area
4 Campbell County.
5 Chesterfield County.
6. Hanover County.
7 Leesburg area.
8 Louisa County.
9 Montgomery County
10 Norfolk area.
11 Prince Edward area.
12 Yorktown area.

WASHINGTON.

1 Bellingham area.
2 Everett area.
3 Island County.
4 Quincy area.
5 Walla Walla area.
6 Yakima area

WEST VIRGINIA.

1 Clarksburg area.
2. Huntington area.
3 Kanawha County
4 Middlebourne area.
5 Morgantown area.
6 Parkersburg area.
7 Point Pleasant area.
8 Preston County.
9 Spencer area
10 Upshur County
11. Wheeling area.

WISCONSIN.

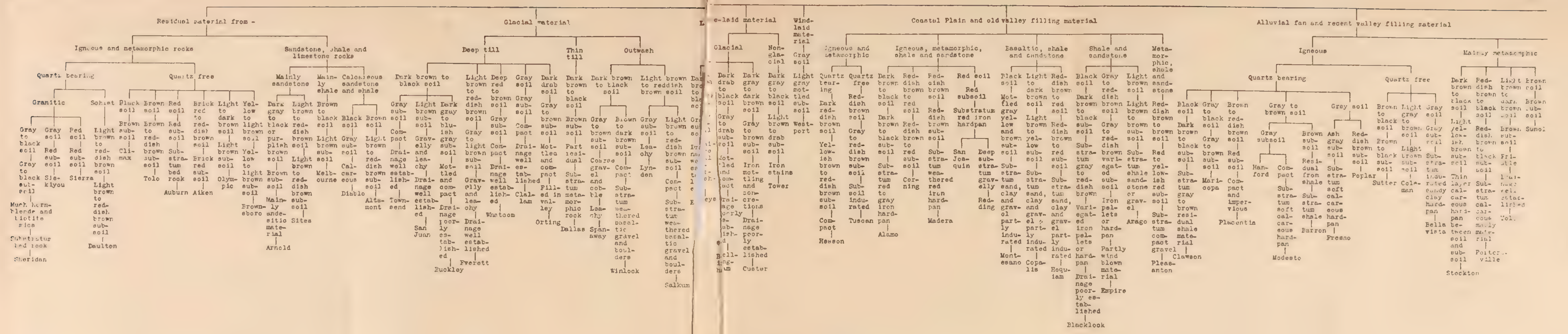
1 Bayfield area.
2 Buffalo County.
3 Columbia County.
4 Dane County.
5 Fond du Lac County.
6 Iowa County.
7 Janesville area.
8. Jefferson County.
9 Juneau County.
10 Kewaunee County
11 La Crosse County.
12 Portage County
13 Racine County.
14 Superior area.
15 Viroqua area.
16 Waukesha County.
17 Waushara County.

WYOMING.

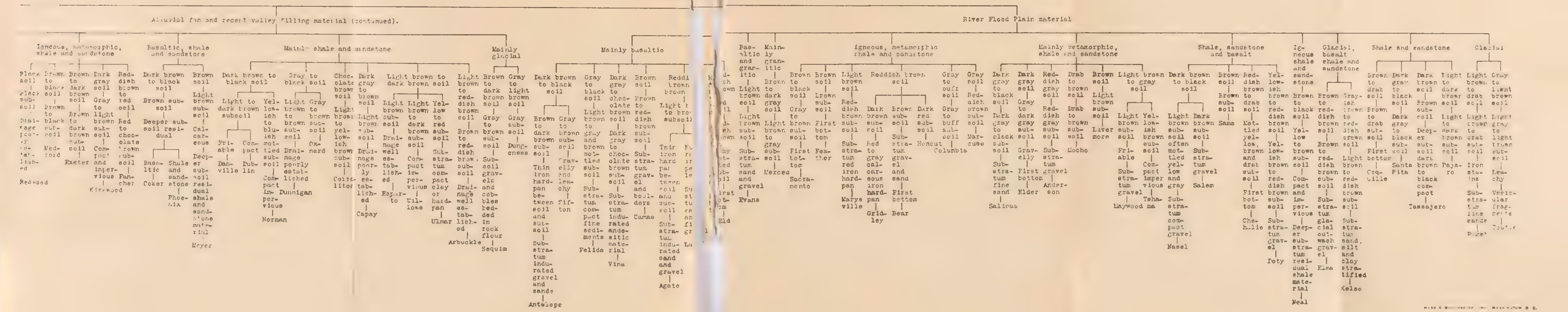
1. Laramie area.

Key to the Soils of the Pacific Coast.

Fig. 13



Key to the Soils of the Pacific Coast (continued).



APPENDIX A.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published.

ALABAMA.

No.	Name of area.	Soil name as published.	Changed to—
1	Autauga County, 1908	Guin gravelly sandy loam	Ruston gravelly sandy loam.
		Orangeburg sand	Orangeburg sandy loam.
		Orangeburg clay	Greenville clay loam.
		Houston chalk	Chalk (Houston material).
2	Baldwin County, 1909		
3	Bibb County, 1908	Waverly silt loam	Bibb silt loam.
4	Blount County, 1905	Fort Payne stony loam	Clarksville stony loam.
		Upshur loam	Decatur loam.
5	Butler County, 1907	Orangeburg clay	Greenville clay loam.
		Orangeburg sand	Orangeburg sandy loam.
6	Calhoun County, 1908		
7	Chambers County, 1909		
8	Chilton County, 1911		
9	Coffee County, 1909	Orangeburg sand	Do.
		Orangeburg fine sand	Orangeburg fine sandy loam.
10	Colbert County, 1908	Leighton loam	Clarksville loam.
		King clay	Colbert clay.
		King clay loam	Colbert clay loam.
11	Cullman County, 1908		
12	Dale County, 1910	Orangeburg sand	Orangeburg sandy loam.
13	Dallas County, 1905	Norfolk clay	Cahaba clay.
		Orangeburg clay	Greenville clay loam.
14	Elmore County, 1911		
15	Etowah County, 1908		
16	Fort Payne area, 1903	Clarksville loam	Huntington silt loam.
		Penn sandy loam	Upshur sandy loam.
		Fort Payne stony loam	Clarksville stony loam.
		Chattooga loam	Holston loam.
17	Hale County, 1909	Guin fine sandy loam	Ruston fine sandy loam.
18	Henry County, 1908		
19	Huntsville area, 1903	Clarksville clay	Elk clay.
		Hagerstown silt loam	Clarksville silt loam.
20	Jackson County, 1911		
21	Jefferson County, 1908	Wabash clay	Huntington clay.
22	Lamar County, 1908	Norfolk loam	Kalmia loam.
		Waverly loam	Bibb loam.
		Guin fine sandy loam	Ruston fine sandy loam.
23	Lauderdale County, 1905	Clarksville loam	Huntington silt loam.
		Clarksville clay loam	Hagerstown loam.
24	Lee County, 1906		
25	Macon County, 1904	Houston black clay	Houston clay.
		Lufkin clay	Susquehanna clay.
		Orangeburg clay	Greenville clay loam.
		Ocklocknee clay	Huntington clay.
26	Madison County, 1911		
27	Marion County, 1907	Norfolk silt loam	Kalmia silt loam.
		Guin fine sandy loam	Ruston fine sandy loam.
28	Marshall County, 1911		
29	Mobile County, 1911		
30	Montgomery County, 1905	Norfolk clay	Cahaba clay.
		Yazoo clay	Trinity clay.
		Congaree clay	Huntington clay.
		Congaree loam	Ocklocknee loam.
31	Perry County, 1902	Norfolk sand	Norfolk fine sand.
		Sassafras sandy loam	Cahaba sandy loam.
		Orangeburg sandy loam	Orangeburg fine sandy loam.
		Orangeburg clay	Do.
32	Pike County, 1910	Orangeburg fine sand	Do.
33	Randolph County, 1911		
34	Sumter County, 1904	Lufkin clay loam	Lufkin clay.
		Warsaw sandy loam	Cahaba fine sandy loam.
		Waverly loam	Ocklocknee loam.
		Orangeburg clay	Greenville clay loam.
35	Talladega County, 1907		
36	Tallapoosa County, 1909	Cecil slate loam	Louisa slate loam.
37	Tuscaloosa County, 1911		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

ARIZONA.

No.	Name of area.	Soil name as published.	Changed to—
1	Salt River Valley area, 1900	Pecos sand	Gila fine sand.
		Salt River adobe	Gila clay.
		Glendale loess	Glendale clay loam.
		Salt River gravel	Rough stony land.
		Maricopa gravelly loam	Glendale gravelly loam.
		Maricopa sandy loam	Glendale fine sandy loam.
		Maricopa loam	Glendale loam.
		Maricopa clay loam	Glendale clay loam.
2	Solomonsville area, 1903	Pecos sand	Gila fine sandy loam.
		Gila fine sandy loam	Gila loam.
		Maricopa sand	Glendale sand.
		Maricopa sandy loam	Glendale sandy loam.
		Maricopa gravelly loam	Glendale loam.
		Maricopa silt loam	Glendale silt loam.
3	Yuma area, 1904	Imperial sand	Gila fine sand.
		Imperial sandy loam	Gila fine sandy loam.
		Imperial fine sandy loam	Gila loam.
		Imperial silt loam	Gila silt loam.
		Imperial loam	Gila clay loam.
		Fresno gravelly sand	Glendale sand.
		Salt River adobe	Gila clay.

ARKANSAS.

No.	Name of area.	Soil name as published.	Changed to—
1	Conway County, 1907	Wabash fine sand	Huntington fine sand.
		Wabash fine sandy loam	Huntington fine sandy loam.
		Wabash silt loam	Huntington silt loam.
		Wabash clay	Huntington clay.
2	Fayetteville area, 1906	Wabash loam	Huntington loam.
		Wabash silt loam	Huntington silt loam.
		Wabash clay loam	Huntington clay loam.
3	Miller County, 1903	Sharkey clay	Miller clay.
4	Prairie County, 1906		
5	Stuttgart area, 1902	Almyra silt loam	Crowley silt loam.
		Miami clay loam	Do.
		Guthrie clay	Waverly silt loam.

CALIFORNIA.

No.	Name of area.	Soil name as published.	Changed to—
1	Bakersfield area, 1904	Maricopa loam	Fresno loam.
		Fresno sand	Hanford sand.
		Fresno fine sand	Hanford fine sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Oxnard silt loam	Hanford clay loam.
		Maricopa sandy adobe	Placentia sandy loam adobe.
2	Colusa area, 1907	Orland fine sandy loam	Yolo fine sandy loam.
		Orland fine sand	Elder fine sand.
		Sacramento gravelly sandy loam.	Yolo gravelly sandy loam.
		Sacramento loam	Yolo loam.
		San Joaquin gravelly loam	Corning gravelly loam.
		San Joaquin fine sandy loam	Corning fine sandy loam.
		San Joaquin loam	Corning loam.
		Sites sandy loam	Sites fine sandy loam.
		Sites loam	Diablo loam.
		Sites clay loam adobe	Diablo clay loam adobe.
		Sacramento fine sandy loam	Columbia fine sandy loam.
3	Fresno area, 1900	Fresno sandy loam	Fresno fine sandy loam.
		Fresno red sand	San Joaquin sand.
		San Joaquin black adobe	Maricopa clay loam adobe.
		Fancher sandy loam	Fancher fine sandy loam.
		San Joaquin red adobe	San Joaquin sandy loam adobe.
		Sierra adobe	Sierra sandy loam adobe.
4	Hanford area, 1901	Fresno sandy loam	Fresno fine sandy loam.
		Fancher sandy loam	Hanford sandy loam.
		San Joaquin black adobe	Maricopa clay loam adobe.
5	Imperial area, 1903	Gila fine sandy loam	Gila loam.
		Imperial loam	Imperial clay loam.
		Imperial gravelly loam	Indio gravelly loam.
6	Indio area, 1903	Fresno sand	Indio sand.
		Fresno sandy loam	Indio fine sand.
		Fresno fine sandy loam	Indio fine sandy loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

CALIFORNIA—Continued.

No.	Name of area.	Soil name as published.	Changed to—
7	Klamath reclamation project area, Oregon, 1908.	Yakima fine sandy loam	Baker fine sandy loam.
		Yakima sandy loam	Langel fine sandy loam.
		Yakima loam	Langel loam.
		Yakima clay loam	Link clay loam.
		Yakima sand	Quincy sand.
		Yakima clay adobe	Ewauna clay adobe.
8	Livermore Valley area, 1910	Contra Costa sandy loam	Sites sandy loam.
		Vallecitos clay adobe	Daulton clay adobe.
		Vallecitos loam	Daulton loam.
		Vallecitos stony clay loam	Daulton stony clay loam.
9	Los Angeles area, 1903	Fresno sand	Hanford sand.
		Fresno fine sand	Hanford fine sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Santiago silt loam	Hanford silt loam.
		Maricopa gravelly loam	Maricopa fine sandy loam.
		Oxnard loam	Oxnard clay loam.
		San Joaquin black adobe	Oxnard clay loam adobe.
		Placentia sandy loam	Placentia fine sandy loam.
		Sierra adobe	Placentia clay loam adobe.
		Galveston clay	Tidal marsh.
		Los Angeles sandy loam	Altamont loam.
		Fullerton sandy adobe	Maricopa loam adobe.
10	Lower Salinas Valley area, 1901	Fresno sand	Hanford sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Santiago silt loam	Hanford clay loam.
		Soledad gravelly sand	Maricopa gravelly sand.
		Arroyo Seco sandy loam	Maricopa gravelly loam.
		Salinas shale loam	Oxnard gravelly loam.
		Placentia sandy loam	Placentia fine sandy loam.
		San Joaquin black adobe	Salinas clay adobe.
		Salinas gray adobe	Salinas clay loam adobe.
11	Madera area, 1910	Fresno clay loam	Modesto clay loam.
		Media coarse sandy loam	Sierra coarse sandy loam.
		Media sandy loam	Sierra sandy loam.
		Media fine sandy loam	Sierra fine sandy loam.
		Media clay adobe	Sierra clay adobe.
12	Marysville area, 1909	Sierra loam	Auburn loam.
		Sacramento fine sand	Columbia fine sand.
13	Modesto-Turlock area, 1908	Arnold sandy loam	Siskiyou sandy loam.
		Hanford silt loam	Merced silty clay loam.
		Oakdale sandy loam	Sacramento sandy loam.
		Oakdale coarse sandy loam	Sacramento coarse sandy loam.
		Oakdale sand	Sacramento sand.
		Stockton loam	Yolo loam.
14	Pajaro Valley area, 1908	Alviso clay	Tidal marsh.
		Encina sandy loam	Melbourne sandy loam.
		Monterey sandy loam	Sites sandy loam.
		Pajaro light silt loam	Pajaro fine sandy loam.
		Pajaro silt clay	Pajaro silty clay.
		Salsipuedes loam	Corralitos loam.
		Santa Cruz loam	Melbourne loam.
		Santa Cruz sand	Sites fine sand.
		Santa Cruz sandy loam	Sites sandy loam.
		Watsonville sandy loam	Melbourne fine sandy loam.
		Watsonville loam	Altamont clay loam.
		Watsonville clay loam adobe	Melbourne clay loam adobe.
15	Portersville area, 1908	Lewis clay loam	Yolo clay loam.
		Portersville coarse sandy loam	Sheridan coarse sandy loam.
		Portersville loam	Hanford loam.
		San Joaquin loam	San Joaquin clay loam.
16	Redbluff area, 1910	Sacramento fine sand	Columbia fine sand.
		Sacramento fine sandy loam	Columbia fine sandy loam.
17	Redding area, 1907	do	Do.
		Sacramento gravelly sandy loam	Bear gravelly sandy loam.
18	Sacramento area, 1904	Fresno red sand	San Joaquin sand.
		Sierra loam	Sierra loam adobe.
		Fresno gravel	Riverwash.
		Fresno fine sand	Sacramento fine sandy loam.
		Salinas gray adobe	Alamo clay adobe.
		San Joaquin red adobe	San Joaquin clay adobe.
		Sierra stony loam	Arnold stony loam.
		Sierra clay loam	Auburn clay loam.
		Sierra sandy loam	Sierra coarse sandy loam.
		Fresno sand	Columbia sand.
19	San Bernardino area, 1904	do	Hanford sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Santiago silt loam	Hanford clay loam.
		Maricopa sandy loam	Maricopa gravelly loam.
		San Gabriel sandy loam	Maricopa sandy loam.
		San Joaquin black adobe	Oxnard clay loam adobe.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

CALIFORNIA—Continued.

No.	Name of area.	Soil name as published.	Changed to—
19	San Bernardino area, 1904 (con.)	Placentia coarse sandy loam	Placentia sandy loam.
		Placentia sandy loam	Placentia fine sandy loam.
		Placentia loam	Placentia clay loam.
		Fullerton sandy adobe	Maricopa loam adobe.
		Salinas gray adobe	Maricopa clay loam adobe.
20	San Gabriel area, 1901	Fresno sand	Hanford sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Santiago silt loam	Hanford silt loam.
		San Gabriel gravelly sand	Maricopa gravelly sand.
		San Gabriel gravelly loam	Maricopa gravelly loam.
		San Joaquin black adobe	Oxnard clay loam adobe.
		Placentia sandy loam	Placentia fine sandy loam.
21	San Jose area, 1903	Arroyo Seco sandy loam	Maricopa gravelly loam.
		Oxnard loam	Oxnard clay loam.
		Placentia sandy loam	Placentia fine sandy loam.
		Galveston clay	Tidal marsh.
		San Joaquin black adobe	Redwood clay adobe.
		Salinas gray adobe	Maricopa clay loam adobe.
		Fresno fine sandy loam	Livermore silt loam.
		Oxnard silt loam	Do.
22	Santa Ana area, 1900	Fresno sand	Hanford sand.
		Fresno fine sandy loam	Hanford fine sandy loam.
		Santiago silt loam	Hanford silt loam.
		Placentia sandy loam	Placentia fine sandy loam.
		San Joaquin black adobe	Maricopa clay loam adobe.
		Santiago sandy loam	Placentia fine sandy loam.
		Santiago loam	Placentia loam.
		Fullerton sandy adobe	Placentia sandy loam adobe.
23	Stockton area, 1905	Sacramento clay loam	Sacramento clay.
		Stockton loam	Yolo loam.
24	Ventura area, 1901	San Gabriel gravelly loam	Maricopa gravelly loam.
		Fresno sand	Maricopa sand.
		Salinas shale loam	Oxnard gravelly loam.
		Fresno fine sandy loam	Oxnard loam.
		Oxnard loam	Oxnard clay loam.
		San Joaquin black adobe	Oxnard clay loam adobe.
		Placentia sandy loam	Placentia loam.
		Fullerton sandy adobe	Placentia clay loam adobe.
25	Woodland area, 1909	Sacramento heavy clay	Sacramento clay.
		Sites gravelly sandy loam	Sites gravelly fine sandy loam.
		Sites clay loam adobe	Diablo clay loam adobe.
		Sites clay adobe	Diablo clay adobe.
		Sites loam	Arbuckle loam.
		Sites silt loam	Arbuckle silt loam.
		Sacramento fine sand	Columbia fine sand.
26	Yuma area, Arizona, 1904	Imperial sand	Gila fine sand.
		Imperial sandy loam	Gila fine sandy loam.
		Imperial fine sandy loam	Gila loam.
		Imperial silt loam	Gila silt loam.
		Imperial loam	Gila clay loam.
		Fresno gravelly sand	Glendale sand.
		Salt River adobe	Gila clay.

COLORADO.

No.	Name of area.	Soil name as published.	Changed to—
1	Grand Junction area, 1905	Mesa clay	Chipeta clay.
		Laurel fine sand	Grand fine sand.
		Laurel sandy loam	Grand sandy loam.
2	Greeley area, 1904	Colorado fine sandy loam	Benton fine sandy loam.
		Colorado loam	Benton loam.
		Colorado adobe	Benton loam adobe.
		Billings loam	Wade loam.
		Billings silt loam	Wade silt loam.
		Billings clay loam	Wade clay loam.
3	Lower Arkansas Valley, 1902	Fresno sand	Colorado sand.
		Maricopa sand	Do.
		Maricopa sandy loam	Colorado sandy loam.
		Maricopa clay loam	Colorado clay loam.
		Fresno fine sand	Laurel fine sand.
		Santiago silt loam	Laurel loam.
		Fresno fine sandy loam	Benton silt loam.
		Maricopa sandy adobe	Benton loam adobe.
		San Joaquin black adobe	Wade clay.
4	San Luis Valley, 1903	Rio Grande sandy loam	Alamosa sandy loam.
		Rio Grande loam	Alamosa clay loam.
5	Uncompahgre Valley, 1910	Laurel loam	Grand loam.
		Laurel silty clay loam	Grand silty clay loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

CONNECTICUT.

No.	Name of area.	Soil name as published.	Changed to—
1	Connecticut Valley, 1903	Connecticut meadows	Podunk silt loam.
		Connecticut swamp	Swamp.
		Triassic stony loam	Wethersfield loam.
		Chicopee gravel loam	Merrimac gravelly sandy loam.
		Norfolk coarse sandy loam	Merrimac coarse sandy loam.
		Windsor sand	Merrimac coarse sand.
		Enfield sandy loam	Manchester fine sand.
		Elmwood loam	Suffield loam.
		Podunk fine sandy loam	Hartford very fine sandy loam.
2	Windham County, 1911		

DELAWARE.

No.	Name of area.	Soil name as published.	Changed to—
1	Dover area, 1903	Galveston sand	Coastal beach.
		Elkton clay	Elkton silt loam.
		Galveston clay	Tidal marsh.
		Norfolk loam	Sassafras sandy loam.
		Norfolk silt loam	Sassafras silt loam.

FLORIDA.

No.	Name of area.	Soil name as published.	Changed to—
1	Escambia County, 1906	Galveston sand	Coastal beach.
		Orangeburg loam	Greenville loam.
2	Gadsden County, 1903	Orangeburg sandy loam	Orangeburg fine sandy loam.
3	Gainesville area, 1904		
4	Jacksonville area, 1910		
5	Jefferson County, 1907		
6	Leon County, 1905	Orangeburg sand	Orangeburg sandy loam.
7	Marianna area, 1909		

GEORGIA.

No.	Name of area.	Soil name as published.	Changed to—
1	Bainbridge area, 1904	Orangeburg sand	Orangeburg sandy loam.
2	Bulloch County, 1910		
3	Chatham County, 1911		
4	Cobb County, 1901	Herndon stony loam	Porters stony loam.
5	Columbia County, 1911		
6	Covington area, 1901		
7	Dodge County, 1904	Norfolk sandy loam	Tifton sandy loam.
8	Fort Valley area, 1903	do	Norfolk fine sandy loam.
		Orangeburg sandy loam	Orangeburg fine sandy loam.
		Selma clay	Cahaba clay.
		Orangeburg clay	Greenville fine sandy loam.
9	Franklin County, 1909		
10	Glynn County, 1911		
11	Grady County, 1908	Orangeburg fine sand	Orangeburg fine sandy loam.
12	Hancock County, 1909		
13	Pike County, 1909		
14	Spalding County, 1905	Cecil sand	Durham sandy loam.
15	Sumter County, 1910	Orangeburg sand	Orangeburg sandy loam.
16	Thomas County, 1908	Orangeburg fine sand	Orangeburg fine sandy loam.
17	Tift County, 1909		
18	Walker County, 1910		
19	Waycross area, 1906		

IDAHO.

No.	Name of area.	Soil name as published.	Changed to—
1	Blackfoot area, 1903	Yakima sand	Winchester sand.
		Yakima loam	Caldwell loam.
2	Boise area, 1901	Boise sandy loam	Boise silt loam.
		Deer Flat sandy loam	Deer Flat fine sandy loam.
		Snake River sand	Yakima fine sand.
		Caldwell sandy loam	Caldwell fine sandy loam.
		Caldwell loam	Caldwell silt loam.
3	Lewiston area, 1902	Yakima fine sandy loam	Walla Walla silt loam.
		Yakima sandy loam	Moscow loam.
		Yakima fine sand	Caldwell fine sandy loam.
		Yakima silt loam	Caldwell silt loam.
4	Minidoka area, 1907	Yakima sand	Quincy sand.
		Yakima sandy loam	Quincy sandy loam.

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Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

ILLINOIS.

No.	Name of area.	Soil name as published.	Changed to—
1	Clay County, 1902	Yazoo sandy loam	Waverly fine sandy loam.
2	Clinton County, 1902	Edgerton silt loam	Miami silt loam.
		Kaskaskia loam	Wabash silt loam.
		Yazoo clay	Wabash clay.
		Miami silt loam	Marshall silt loam.
3	Dubuque area, Iowa, 1902	Lintonia loam	Wabash silt loam.
		Clarksville stony loam	Rough stony land.
		Miami fine sand	Lintonia fine sand.
		Miami silt loam	Knox silt loam.
		Miami sandy loam	Knox sandy loam.
4	Johnson County, 1903	Yazoo clay	Wabash clay.
5	Knox County, 1903	Kaskaskia loam	Wabash silt loam.
		Miami silt loam	Knox silt loam.
		Miami black clay loam	Marshall black clay loam.
6	McLean County, 1903	Kaskaskia loam	Wabash silt loam.
		Miami silt loam	Knox silt loam.
		McLean silt loam	Marshall loam.
		Miami black clay loam	Marshall black clay loam.
7	O'Fallon area, Missouri, 1904	Miami fine sand	Lintonia fine sand.
		Yazoo clay	Wabash clay.
		Miami silt loam	Knox silt loam.
8	Sangamon County, 1903	Kaskaskia loam	Wabash silt loam.
		Miami fine sand	Knox fine sand.
		Miami black clay loam	Marshall black clay loam.
		Miami silt loam	Knox silt loam.
9	St. Clair County, 1902	Miami fine sandy loam	Memphis silt loam.
		Kaskaskia loam	Wabash silt loam.
		Yazoo clay	Wabash clay.
		Miami silt loam	Marshall silt loam.
		Lintonia loam	Lintonia silt loam.
10	Tazewell County, 1902	do	Wabash loam.
		Miami fine sand	Knox fine sand.
		Yazoo clay	Wabash clay.
		Miami black clay loam	Marshall black clay loam.
		Mackinaw gravel	Judson gravel.
		Tazewell silt loam	Knox silt loam.
		Miami loam	Sioux loam.
		Delavan silt loam	Plainfield silt loam.
11	Winnebago County, 1903	Winnebago sandy loam	Carrington sandy loam.
		Miami fine sand	Coloma fine sand.
		Miami silt loam	Knox silt loam.
		Miami gravel	Judson gravel.
		Sioux sandy loam	Plainfield sandy loam.

INDIANA.

1	Allen County, 1908	Miami black clay loam	Carrington black clay loam.
2	Boonville area, 1904	Miami silt loam	Knox silt loam.
		Miami fine sandy loam	Lintonia fine sandy loam.
3	Greene County, 1906	Bloomfield sandy loam	Knox sandy loam.
		Miami sand	Knox sand.
		Miami silt loam	Knox silt loam.
		Marco fine sandy loam	Lintonia fine sandy loam.
		Marco clay loam	Wabash clay loam.
		Huntington fine sandy loam	Wabash loam.
		Huntington silt loam	Wabash silt loam.
4	Madison County, 1903	Miami black clay loam	Carrington black clay loam.
		Madison loam	Sioux clay loam.
5	Marion County, 1907	Miami black clay loam	Carrington black clay loam.
		Miami gravelly loam	Chenango gravelly loam.
		Miami loam	Sioux loam.
		Huntington loam	Wabash loam.
		Miami sandy loam	Chenango sandy loam.
6	Marshall County, 1904	Marshall sandy loam	Waukesha sandy loam.
		Marshall loam	Carrington loam.
		Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Miami sand	Coloma sand.
		Miami black clay loam	Carrington black clay loam.
		Marshall sand	Waukesha sand.
7	Newton County, 1905	Kaskaskia loam	Wabash silt loam.
		Miami black clay loam	Carrington black clay loam.
		Miami fine sand	Dunkirk fine sand.
		Marshall loam	Carrington loam.
		Marshall fine sand	Waukesha sand.
		Marshall fine sandy loam	Carrington fine sandy loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

INDIANA—Continued.

No.	Name of area.	Soil name as published.	Changed to—
8	Posey County, 1902	Memphis silt loam	Lintonia silt loam.
		Miami sandy loam	Wabash fine sandy loam.
		Waverly silt loam	Wabash silt loam.
		Miami fine sandy loam	Waverly fine sandy loam.
		Yazoo loam	Waverly loam.
		Guthrie clay	Waverly clay loam.
		Yazoo clay	Waverly clay.
		Miami sand	Knox sand.
		Miami silt loam	Knox silt loam.
9	Scott County, 1904		
10	Tippecanoe County, 1905	Marshall loam	Carrington silt loam.
		Miami black clay loam	Marshall black clay loam.
		Miami loam	Miami silt loam.
		Miami fine sandy loam	Knox fine sandy loam.
		Miami fine sand	Knox fine sand.
		Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Miami silt loam	Knox silt loam.

IOWA.

No.	Name of area.	Soil name as published.	Changed to—
1	Cerro Gordo County, 1903	Miami black clay loam	Carrington black clay loam.
		Marshall clay loam	Carrington clay loam.
		Marshall loam	Carrington loam.
		Marshall sand	Waukesha sand.
2	Dubuque area, 1902	Lintonia loam	Wabash silt loam.
		Clarksville stony loam	Rough stony land.
		Miami sandy loam	Knox sandy loam.
		Miami silt loam	Knox silt loam.
		Miami fine sand	Lintonia fine sand.
3	Story County, 1903	Miami black clay loam	Wabash clay loam.
		Marshall clay loam	Carrington clay loam.
		Marshall loam	Carrington loam.
4	Tama County, 1904	Kaskaskia loam	Wabash silt loam.
		Miami fine sand	Knox fine sand.
		Miami silt loam	Knox silt loam.
		Marshall loam	Carrington loam.

KANSAS.

No.	Name of area.	Soil name as published.	Changed to—
1	Allen County, 1904	Sharkey clay	Wabash clay.
		Yazoo clay	Do.
		Sedgwick gravelly loam	Crawford gravelly loam.
		Sedgwick clay loam	Crawford silt loam.
2	Brown County, 1905	Yazoo silt loam	Wabash silt loam.
		Marshall sandy loam	Carrington sandy loam.
		Marshall gravelly loam	Carrington gravelly loam.
3	Garden City area, 1904	Colorado adobe	Laurel loam adobe.
		Colorado sand	Richfield sand.
		Finney clay	Hoisington clay.
		Marshall silt loam	Richfield silt loam.
4	Parsons area, 1903	Oswego silt loam	Neosho silt loam.
		Sharkey clay	Wabash clay.
		Yazoo clay	Crawford clay.
		Oswego loam	Oswego silt loam.
5	Platte County, Mo., 1911		
6	Reno County, 1911		
	Riley County, 1906	Wabash silt clay	Wabash silty clay.
		Laurel silt loam	Arkansas silt loam.
		Laurel fine sandy loam	Arkansas fine sandy loam.
		Laurel fine sand	Arkansas fine sand.
8	Russell area, 1903	Waldo loam	Wabash silt loam.
		Sedgwick clay loam	Oswego silt loam.
		Lincoln sandy loam	Laurel fine sandy loam.
		Sedgwick sandy loam	Oswego sandy loam.
		Benton loam	Benton stony loam.
9	Shawnee County, 1911		
10	Western Kansas reconnoissance, 1910.	Protection loam	Richfield loam.
		Russell sandy loam	Oswego sandy loam.
11	Wichita area, 1902	Clarksville stony loam	Rough stony land.
		Sedgwick clay loam	Crawford silt loam.
		Sedgwick sandy loam	Pratt sandy loam.
		Sedgwick loam	Pratt loam.
		Miami sand	Arkansas sand.
		Miami fine sand	Arkansas fine sand.
		Sedgwick black clay loam	Sedgwick clay loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

KENTUCKY.

No.	Name of area.	Soil name as published.	Changed to—
1	McCracken County, 1905		
2	Madison County, 1905	Wabash silt loam	Huntington silt loam.
3	Mason County, 1903	Norfolk fine sandy loam	Cumberland fine sandy loam.
		Norfolk loam	Cumberland sandy loam.
		Leonardtown loam	Huntington silt loam.
		Elkton clay	Holly clay loam.
4	Rockcastle County, 1910		
5	Scott County, 1903		
6	Union County, 1902	Miami silt loam	Knox silt loam.
		Sturgis fine sandy loam	Lintonia fine sandy loam.
		Waverly silt loam	Wabash silt loam.
		Miami fine sandy loam	Waverly fine sandy loam.
		Sharkey clay	Waverly clay.
		Yazoo clay	Do.
		Memphis silt loam	Lintonia silt loam.
7	Warren County, 1904	Clarksville loam	Huntington silt loam.

LOUISIANA.

No.	Name of area.	Soil name as published.	Changed to—
1	Acadia Parish, 1903		
2	Bienville Parish, 1908		
3	Caddo Parish, 1906	Orangeburg fine sand	Orangeburg fine sandy loam.
4	Concordia Parish, 1910	Yazoo clay	Sarpy clay.
5	De Soto Parish, 1904		
6	East Carroll and West Carroll Parishes, 1908.	Yazoo coarse sand	Riverwash.
7	East Baton Rouge Parish, 1905.	Yazoo clay	Wabash clay.
8	Lake Charles area, 1901	Calcasieu fine sand	Caddo fine sand.
		Calcasieu fine sandy loam	Caddo fine sandy loam.
		Calcasieu loam	Caddo loam.
9	Lincoln Parish, 1909		
10	Iberia Parish, 1911		
11	New Orleans area, 1903	Galveston clay	Tidal marsh.
		Yazoo clay	Sharkey clay.
12	Ouachita area, 1903	Monroe fine sandy loam	Miller fine sandy loam.
13	Tangipahoa Parish, 1905	Yazoo clay	Sharkey clay.
14	Winn Parish, 1907		

MAINE.

No.	Name of area.	Soil name as published.	Changed to—
1	Caribou area, 1908		
2	Orono area, 1909		

MARYLAND.

No.	Name of area.	Soil name as published.	Changed to—
1	Anne Arundel County, 1909		
2	Calvert County, 1900	Susquehanna gravel	Norfolk gravel.
		Windsor sand	Norfolk coarse sand.
		Norfolk loam	Sassafras loam.
		Sassafras loam	Sassafras silt loam.
		Sassafras sandy loam	Sassafras fine sandy loam.
3	Cecil County, 1900	Elkton clay	Elkton silt loam.
		Sassafras loam	Sassafras silt loam.
		Cecil mica loam	Manor loam.
		Cecil loam	Chester loam.
		Norfolk sand	Sassafras sand.
		Conowingo barrens	Barrens (Conowingo material).
4	Easton area, 1907		
5	Harford County, 1901	Norfolk sand	Sassafras sand.
		Elkton clay	Elkton silt loam.
		Sassafras loam	Sassafras silt loam.
		Cecil mica loam	Manor loam.
		Cecil loam	Chester loam.
		Conowingo barrens	Barrens (Conowingo material).
6	Kent County, 1900	Elkton clay	Elkton silt loam.
		Susquehanna gravel	Norfolk gravel.
		Sassafras loam	Sassafras silt loam.
		Norfolk sand	Sassafras sand.
7	Leesburg area, Virginia, 1903	Loudoun sandy loam	Chester sandy loam.
		Cecil mica loam	Manor loam.
		Hagerstown shale loam	Dekalb shale loam.
		Cecil loam	Chester loam.
		Cecil silt loam	Lansdale silt loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

MARYLAND—Continued.

No.	Name of area.	Soil name as published.	Changed to—
8	Prince George County, 1901	Elkton clay	Elkton silt loam.
		Leonardtown gravelly loam	Leonardtown loam.
		Susquehanna gravel	Norfolk gravel.
		Windsor sand	Norfolk coarse sand.
		Westphalia sand	Sassafras fine sand.
		Norfolk loam	Sassafras fine sandy loam.
		Sassafras loam	Sassafras silt loam.
		Cecil mica loam	Manor loam.
9	St. Mary County, 1900	Susquehanna gravel	Norfolk gravel.
		Windsor sand	Norfolk coarse sand.
		Norfolk loam	Sassafras fine sandy loam.
		Sassafras loam	Sassafras silt loam.
		Norfolk sand	Sassafras sand.
10	Worcester County, 1903	Galveston sand	Coastal beach.
		Elkton clay	Elkton silt loam.
		Galveston clay	Tidal marsh.

MASSACHUSETTS.

No.	Name of area.	Soil name as published.	Changed to—
1	Connecticut Valley, 1903	Connecticut meadows	Podunk silt loam.
		Connecticut swamp.	Swamp.
		Triassic stony loam	Wethersfield loam.
		Chicopee gravel loam	Merrimac gravelly sandy loam.
		Norfolk coarse sandy loam	Merrimac coarse sandy loam.
		Windsor sand	Merrimac coarse sand.
		Enfield sandy loam	Manchester fine sand.
		Elmwood loam	Suffield loam.
		Podunk fine sandy loam	Hartford very fine sandy loam.
2	Plymouth County, 1911	Carver gravelly sandy loam	Merrimac gravelly sandy loam.
		Carver coarse sandy loam	Merrimac coarse sandy loam.
		Carver sandy loam	Merrimac sandy loam.
		Carver fine sandy loam	Merrimac fine sandy loam.

MICHIGAN.

No.	Name of area.	Soil name as published.	Changed to—
1	Allegan County, 1901	Allegan black clay	Clyde loam.
		Kalamazoo gravelly loam	Clyde gravelly sand.
		Allegan clay	Miami clay loam.
		Plainwell stony loam	Coloma stony sand.
		Allegan gravelly loam	Coloma gravelly sand.
		Allegan sand	Coloma sand.
		Allegan fine sandy loam	Coloma fine sand.
		Allegan sandy loam	Coloma sandy loam.
		Allegan stony loam	Miami loam.
2	Alma area, 1904	Miami gravelly sand	Coloma gravelly sandy loam.
		Miami sand	Coloma sand.
3	Cass County, 1906	Miami fine sandy loam	Coloma fine sandy loam.
		Miami sandy loam	Coloma sandy loam.
		Miami stony loam	Miami loam.
		Miami sand	Coloma sand.
		Miami fine sand	Coloma fine sand.
		Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Marshall loam	Carrington loam.
4	Munising area, 1904	Miami sand	Coloma sand.
		Miami sandy loam	Coloma sandy loam.
		Fort Payne sandy loam	Cossayuna fine sandy loam.
5	Owosso area, 1904	Saginaw sandy loam	Clyde sandy loam.
		Miami fine sand	Dunkirk fine sand.
		Miami gravelly sand	Dunkirk gravelly sand.
		Miami sand	Plainfield sand.
6	Oxford area, 1905	Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Miami sand	Coloma fine sand.
		Miami sandy loam	Coloma sandy loam.
		Miami gravelly sand	Coloma gravelly sand.
		Miami black clay loam	Carrington black clay loam.
7	Pontiac area, 1903	Miami loam	Wabash loam.
		Miami sandy loam	Coloma sandy loam.
		Miami black clay loam	Carrington black clay loam.
		Plainwell stony loam	Coloma stony sand.
		Allegan gravelly loam	Coloma gravelly sandy loam.
		Oakland sandy loam	Miami fine sandy loam.
		Miami gravelly loam	Chenango gravelly loam.
		Miami sand	Coloma sand.
		Marshall gravel	Coloma gravelly sand.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

MICHIGAN—Continued.

No.	Name of area.	Soil name as published.	Changed to—
8	Saginaw area, 1904	Saginaw sandy loam	Clyde sandy loam.
		Miami sand	Coloma sand.
		Miami fine sand	Dunkirk fine sand.
		Miami gravelly sand	Dunkirk gravelly sand.
9	Toledo area, Ohio, 1902	Miami black clay loam	Clyde clay.
		Miami sand	Dunkirk sand.
		Miami sandy loam	Dunkirk sandy loam.
		Miami clay loam	Dunkirk clay loam.
		Miami loam	Wabash loam.
10	Wexford County, 1908	Miami sand	Coloma sand.
		MINNESOTA.	
1	Blue Earth County, 1906	Marshall silt loam	Carrington silt loam.
		Marshall clay loam	Carrington clay loam.
		Marshall loam	Carrington loam.
		Marshall fine sandy loam	Carrington fine sandy loam.
		Mankato sand	Sioux sand.
2	Carlton area, 1905	Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Miami fine sand	Coloma fine sand.
		Miami sandy loam	Coloma sandy loam.
		Miami stony loam	Miami loam.
		Miami sand	Coloma sand.
		Barnum loam	Kewaunee loam.
		Barnum stony loam	Kewaunee stony loam.
3	Crookston area, 1906	Benoit loam	Fargo loam.
		McLeod sand	Dunkirk sand.
		Sioux gravelly sandy loam	Fargo gravelly sandy loam.
4	Marshall area, 1903	Miami loam	Wabash loam.
		Fairview sandy loam	Marshall sandy loam.
		Miami black clay loam	Fargo loam.
		Marshall loam	Carrington loam.
		Marshall gravelly loam	Carrington gravelly loam.
		Marshall gravel	Carrington gravel.
		Marshall sandy loam	Sioux sandy loam.
5	Rice County, 1909		
6	Superior area, Wisconsin, 1904	Miami sandy loam	Coloma sandy loam.
		Miami sand	Coloma sand.
		MISSISSIPPI.	
1	Adams County, 1910		
2	Biloxi area, 1904		
3	Clay County, 1909	Houston chalk	Chalk (Houston material).
4	Crystal Springs area, 1905		
5	Forrest County, 1911		
6	Holmes County, 1908	Lintonia loam	Lintonia silt loam.
7	Jackson area, 1904		
8	Jasper County, 1907	Orangeburg loam	Greenville loam.
		Orangeburg clay	Greenville clay loam.
		Orangeburg fine sand	Orangeburg fine sandy loam.
9	Lauderdale County, 1910	Orangeburg sand	Orangeburg sandy loam.
		Orangeburg fine sand	Orangeburg fine sandy loam.
10	Lowndes County, 1911	Houston chalk	Chalk (Houston material).
11	McNeill area, 1903	Neuse clay	Congaree clay.
12	Monroe County, 1908	Amory fine sandy loam	Cahaba fine sandy loam.
		Orangeburg clay	Greenville clay loam.
		Guin fine sandy loam	Ruston fine sandy loam.
		Houston chalk	Chalk (Houston material).
13	Montgomery County, 1906	Lintonia loam	Lintonia silt loam.
14	Noxubee County, 1910	Houston chalk	Chalk (Houston material).
15	Oktibbeha County, 1907	Waverly loam	Bibb loam.
		Waverly clay	Bibb clay.
		Wabash clay	Trinity clay.
		Oktibbeha silt loam	Pheba silt loam.
		Orangeburg clay	Greenville clay loam.
		Houston chalk	Chalk (Houston material).
16	Pontotoc County, 1906	Orangeburg clay	Greenville clay loam.
17	Prentiss County, 1907	Norfolk loam	Kalmia loam.
		Guin fine sandy loam	Ruston fine sandy loam.
18	Scranton area, 1909		
19	Smedes area, 1902	Lintonia loam	Lintonia silt loam.
		Yazoo clay	Sharkey clay.
20	Wayne County, 1911		
21	Yazoo area, 1901	Lintonia loam	Lintonia silt loam.
		Yazoo clay	Sharkey clay.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

MISSOURI.

No.	Name of area.	Soil name as published.	Changed to—
1	Atchison County, 1909	Laurel fine sandy loam	Arkansas fine sandy loam.
2	Audrain County, 1911		
3	Bates County, 1908	Sedgwick black clay loam	Sedgwick clay loam.
4	Cape Girardeau County, 1910		
5	Cedar County, 1909		
6	Cooper County, 1909		
7	Crawford County, 1905		
8	Franklin County, 1911		
9	Howell County, 1902	Clarksville loam	Wabash silt loam.
10	Jackson County, 1910		
11	Laclede County, 1911		
12	Macon County, 1911		
13	Marion County, 1910		
14	O'Fallon area, 1904	Miami silt loam	Knox silt loam.
		Miami fine sand	Lintonia fine sand.
		Yazoo clay	Wabash clay.
15	Pemiscot County, 1910		
16	Platte County, 1911		
17	Putnam County, 1906	Shelby silt loam	Putnam silt loam.
18	Saline County, 1904	Clarksville loam	Wabash silt loam.
		Miami silt loam	Knox silt loam.
		Yazoo clay	Wabash clay.
19	Scotland County, 1905	Shelby silt loam	Putnam silt loam.
20	Shelby County, 1903	Shelby clay	Shelby loam.
		Shelby silt loam	Putnam silt loam.
		Shelby sand	Mankato sand.
21	Sullivan County, 1911		
22	Webster County, 1904	Clarksville loam	Huntington silt loam.

MONTANA.

No.	Name of area.	Soil name as published.	Changed to—
1	Billings area, 1902	Billings sandy loam	Wade fine sandy loam.
		Billings gravelly loam	Wade gravelly loam.
		Billings loam	Wade clay loam.
		Billings clay	Wade clay.
2	Gallatin Valley area, 1905	Yakima silt loam	Manhattan silt loam.

NEBRASKA.

No.	Name of area.	Soil name as published.	Changed to—
1	Grand Island area, 1903	Miami sand	Knox sand.
2	Kearney area, 1904		
3	Lancaster County, 1906	Marshall loam	Carrington loam.
4	North Platte area, 1907	North Platte loam	Cheyenne loam.
5	Sarpy County, 1905	Miami silt loam	Knox silt loam.
6	Stanton area, 1903	Arkansas fine sandy loam	Wabash fine sandy loam.
		Elkhorn silt loam	Wabash silt loam.
		Miami fine sand	Knox fine sand.
7	Western Nebraska Reconnoissance, 1911.		

NEVADA.

No.	Name of area.	Soil name as published.	Changed to—
1	Fallon area, 1909	Fernley fine sand	Lahontan fine sand.

NEW HAMPSHIRE.

No.	Name of area.	Soil name as published.	Changed to—
1	Merrimack County, 1906		
2	Nashua area, 1909		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

NEW JERSEY.

No.	Name of area.	Soil name as published.	Changed to—
1	Salem area, 1901	Norfolk sand	Sassafras sand.
		Sassafras loam	Sassafras silt loam.
		Quinton sandy loam	Norfolk sandy loam.
		Elkton clay	Elkton silt loam.
		Windsor sand	Norfolk coarse sand.
		Elsinboro fine sand	Sassafras fine sandy loam.
		Westphalia sand	Sassafras sand.
2	Sussex area, 1911		
3	Trenton area, 1902	Susquehanna gravel	Norfolk gravel.
		Windsor sand	Norfolk coarse sand.
		Elsinboro fine sand	Sassafras fine sand.
		Quinton sandy loam	Norfolk sandy loam.
		Sassafras loam	Sassafras silt loam.
		Cecil loam	Cecil stony loam.
		Westphalia sand	Norfolk fine sand.

NEW MEXICO.

No.	Name of area.	Soil name as published.	Changed to—
1	Pecos Valley, 1899	Pecos sand	Gila fine sand.
		Pecos gypsum	Gypsum.
		Hondo meadows	Meadow.
		Roswell sandy loam	Roswell fine sandy loam.
		Pecos sandy loam	Roswell sandy loam.
		Pecos conglomerate	Conglomerate.

NEW YORK.

No.	Name of area.	Soil name as published.	Changed to—
1	Auburn area, 1904	Miami fine sand	Dunkirk fine sand.
		Miami loam	Genesee loam.
		Miami stony loam	Ontario loam.
2	Bigflats area, 1902	Elmira fine sandy loam	Genesee fine sandy loam.
		Hagerstown shale loam	Volusia silt loam.
		Miami gravelly loam	Chenango gravelly loam.
		Elmira shale loam	Chenango shale loam.
		Elmira silt loam	Chenango silt loam.
3	Binghamton area, 1905	Wabash loam	Genesee loam.
		Dunkirk gravelly sandy loam	Chenango gravelly sandy loam.
		Dunkirk gravelly loam	Chenango gravelly loam.
		Dunkirk silt loam	Chenango silt loam.
		Dunkirk shale loam	Chenango shale loam.
		Dunkirk fine sandy loam	Chenango fine sandy loam.
4	Dutchess County, 1907	Rhinebeck loam	Hudson silt loam.
		Huntington silt loam	Ondawa silt loam.
		Merrimac gravelly loam	Fox gravelly loam.
		Merrimac gravelly sandy loam	Fox gravelly sandy loam.
		Merrimac loam	Fox loam.
5	Jefferson County, 1911		
6	Livingston County, 1908	Warren shale loam	Volusia shale loam.
7	Long Island area, 1903	Miami stony loam	Flushing loam.
		Alton stony loam	Plymouth sandy loam.
		Plainwell stony loam	Plymouth stony sand.
		Galveston sand	Coastal beach.
		Norfolk gravel	Susquehanna gravel.
		Sassafras sandy loam	Sassafras loam.
		Galveston sandy loam	Tidal marsh.
		Galveston clay	Do.
		Norfolk sand	Sassafras sand.
		Norfolk coarse sand	Merrimac coarse sand.
		Norfolk coarse sandy loam	Merrimac coarse sandy loam.
8	Lyons area, 1902	Alton stony loam	Dunkirk stony loam.
		Miami fine sand	Dunkirk fine sand.
		Miami loam	Genesee loam.
		Miami stony loam	Ontario loam.
		Miami fine sandy loam	Dunkirk fine sandy loam.
		Elmira silt loam	Dunkirk silt loam.
		Alloway clay	Dunkirk clay.
9	Madison County, 1906	Miami stony loam	Cazenovia loam.
		Miami fine sand	Dunkirk fine sand.
		Miami fine sandy loam	Dunkirk fine sandy loam.
		Huntington loam	Genesee loam.
10	Monroe County, 1910		
11	Montgomery County, 1908	Nellis loam	Farmington loam.
12	Niagara County, 1906	Huntington loam	Genesee loam.
13	Ontario County, 1910		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

NEW YORK—Continued.

No.	Name of area.	Soil name as published.	Changed to—
14	Syracuse area, 1903	Alloway clay	Dunkirk clay.
		Miami fine sand	Dunkirk fine sand.
		Miami silt loam	Dunkirk silt loam.
		Miami loam	Genesee loam.
		Penn clay	Upshur clay.
		Miami stony loam	Cazenovia loam.
		Miami gravelly loam	Dunkirk gravelly loam.
		Miami fine sandy loam	Dunkirk fine sandy loam.
		Alton stony loam	Ontario stony loam.
15	Tompkins County, 1905	Wabash loam	Genesee loam.
		Miami stony loam	Ontario loam.
16	Vergennes area, Vermont, 1904.	Alton stony loam	Adirondack stony sandy loam.
17	Washington County, 1909		
18	Westfield area, 1901	Dunkirk shale loam	Volusia shale loam.
		Volusia sandy loam	Volusia loam.
		Dunkirk gravelly loam	Dunkirk gravelly sandy loam.
		Dunkirk sandy loam	Dunkirk fine sandy loam.
		Cassadaga sand	Meadow.

NORTH CAROLINA.

No.	Name of area.	Soil name as published.	Changed to—
1	Alamance County, 1901	Herndon stony loam	Porters stony loam.
2	Asheville area, 1903		
3	Cabarrus County, 1910		
4	Cary area, 1901		
5	Caswell County, 1908	Caswell sandy loam	Rough gullied land.
6	Chowan County, 1906	Norfolk silt loam	Norfolk loam.
7	Craven area, 1903	Portsmouth clay	Portsmouth loam.
		Selma clay	Cahaba clay.
		Neuse clay	Congaree clay.
		Norfolk sand	Norfolk fine sand.
8	Duplin County, 1905		
9	Edgecombe County, 1907		
10	Gaston County, 1909		
11	Granville County, 1910		
12	Greenville area, Tennessee, 1904	Fort Payne stony loam	Clarksville stony loam.
		Fort Payne clay	Conestoga clay.
		Fort Payne loam	Hagerstown loam.
		Decatur clay	Hagerstown clay.
13	Henderson County, 1907		
14	Hickory area, 1902		
15	Johnston County, 1911		
16	Lake Mattamuskeet area, 1909.	Hyde mucky loam	Muck (Hyde mucky loam).
17	Mecklenburg area, 1910		
18	Mount Mitchell area, 1902		
19	New Hanover County, 1906	Galveston sand	Coastal beach.
		Galveston fine sand	Do.
		Galveston clay	Tidal marsh.
20	Pasquotank and Perquimans Counties, 1905.		
21	Pitt County, 1909		
22	Raleigh to Newbern, 1900	Neuse clay	Congaree clay.
		Norfolk sandy soil	Norfolk sandy loam.
		Selma silt loam	Do.
		Garner stony loam	Susquehanna gravelly loam.
		Goldsboro compact sandy loam	Portsmouth sandy loam.
		Pocoson	Swamp.
		Savanna	Do.
		Selma heavy silt loam	Portsmouth fine sandy loam.
		Norfolk sand	Norfolk fine sand.
		Susquehanna gravel	Norfolk gravel.
23	Richmond County, 1911		
24	Robeson County, 1903		
25	Scotland County, 1909		
26	Statesville area, 1901	Davie clay loam	Louisa loam.
		Herndon stony loam	Porters stony loam.
27	Transylvania County, 1906		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

NORTH DAKOTA.

No.	Name of area.	Soil name as published.	Changed to—
1	Cando area, 1904	Marshall loam	Carrington loam.
		Marshall gravel	Carrington gravel.
		Clyde loam	Fargo loam.
2	Carrington area, 1905	Marshall loam	Carrington loam.
		Hobart clay	Rough broken land.
		Carrington clay loam	Wabash clay loam.
		Marshall silt loam	Carrington silt loam.
		Marshall stony loam	Carrington stony loam.
		Marshall gravelly loam	Carrington gravelly loam.
3	Fargo area, 1903	Miami loam	Fargo fine sandy loam.
		Wheatland sandy loam	Carrington sandy loam.
		Miami black clay loam	Fargo clay loam.
		Wheatland sand	Fargo sand.
		Marshall clay	Fargo clay.
		Marshall loam	Fargo loam.
		Marshall gravelly loam	Fargo gravelly loam.
4	Grand Forks area, 1902	Miami loam	Fargo loam.
		Miami black clay loam	Fargo silt loam.
		Miami sandy loam	Fargo fine sandy loam.
		Fargo gravelly loam	Carrington gravelly loam.
5	Jamestown area, 1903	Miami black clay loam	Carrington black clay loam.
		Hobart clay	Rough broken land.
		Marshall silt loam	Carrington silt loam.
		Marshall loam	Carrington loam.
		Marshall stony loam	Carrington stony loam.
6	McKenzie area, 1907	Scoria gravel	Rough broken land.
7	Morton area, 1907		
8	Ransom County, 1906	Marshall clay loam	Carrington clay loam.
		Marshall fine sandy loam	Carrington fine sandy loam.
		Marshall stony loam	Carrington stony loam.
		Marshall gravelly loam	Carrington gravelly loam.
		McLeod sand	Dunkirk sand.
9	Richland County, 1908	Marshall loam	Carrington loam.
		Marshall gravelly sandy loam	Carrington gravelly sandy loam.
10	Western North Dakota Reconnoissance, 1908.		
11	Williston area, 1906	Finney clay	Fargo clay.

OHIO.

No.	Name of area.	Soil name as published.	Changed to—
1	Ashtabula area, 1903	Dunkirk gravelly loam	Dunkirk gravelly sandy looam.
		Dunkirk sandy loam	Dunkirk fine sandy loam.
2	Auglaize County, 1909	Miami black clay loam	Carrington black clay loam.
3	Cleveland area, 1905	Miami stony loam	Miami loam.
4	Columbus area, 1902	Miami loam	Wabash loam.
		Miami black clay loam	Carrington black clay loam.
		Miami gravelly loam	Chenango gravelly loam.
5	Coshocton County, 1904	Miami loam	Wabash loam.
		Miami gravelly loam	Chenango gravelly loam.
6	Meigs County, 1906		
7	Montgomery County, 1900	Miami sandy loam	Wabash sandy loam.
		Miami loam	Wabash loam.
		Miami black clay loam	Carrington black clay loam.
		Miami gravelly loam	Chenango gravelly loam.
8	Toledo area, 1902	Miami loam	Wabash loam.
		Miami black clay loam	Clyde clay.
		Miami clay loam	Dunkirk clay loam.
		Miami sand	Dunkirk sand.
		Miami sandy loam	Dunkirk sandy loam.
9	Westerville area, 1905	Miami loam	Wabash loam.
		Miami black clay loam	Carrington black clay loam.
		Miami gravelly loam	Chenango gravelly loam.
10	Wooster area, 1904	Yazoo clay	Wabash clay.
		Miami stony loam	Miami loam.
		Miami gravelly loam	Chenango gravelly loam.
		Miami sand	Coloma sand.
		Miami sandy loam	Dunkirk sandy loam.

OKLAHOMA.

1	Oklahoma County, 1906	Wabash silt clay	Wabash silty clay.
2	Tishomingo area, 1906		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

OREGON.

No.	Name of area.	Soil name as published.	Changed to—
1	Baker City area, 1903	Muck	Meadow.
		Yakima sandy loam	Baker loam.
		Maricopa sandy loam	Hutchinson loam.
		Maricopa gravelly loam	Hutchinson gravelly loam.
		Yakima loam	Caldwell loam.
2	Klamath Reclamation Project area, 1908.	Yakima clay adobe	Ewauna clay adobe.
		Yakima sand	Quincy sand.
		Yakima clay loam	Link clay loam.
		Yakima loam	Langel loam.
		Yakima sandy loam	Langel fine sandy loam.
		Yakima fine sandy loam	Baker fine sandy loam.
3	Marshfield area, 1909	Myrtle clay	Melbourne clay.
		Riverton clay loam	Altamont clay loam.
4	Medford area, 1911		
5	Salem area, 1903	Salem sandy loam	Salem fine sandy loam.
		Salem loam	Salem silt loam.
		Salem clay	Aiken clay.

PENNSYLVANIA.

No.	Name of area.	Soil name as published.	Changed to—
1	Adams County, 1904	Cecil clay loam	Montalto clay loam.
		Cecil loam	Chester loam.
		Cecil stony loam	Montalto stony loam.
2	Bedford County, 1911		
3	Berks County, 1909		
4	Bradford County, 1911		
5	Center County, 1908		
6	Chester County, 1905	Brandywine loam	Manor loam.
		Norfolk silt loam	Sassafras silt loam.
		Portsmouth silt loam	Elkton silt loam.
		Conowingo barrens	Barrens (Conowingo material).
7	Erie County, 1910		
8	Johnstown area, 1907	Chemung stony loam	Chemung shale loam.
9	Lancaster area, 1900	Hempfield stony loam	Cecil stony loam.
		Cecil mica loam	Manor loam.
		Edgemont stony loam	Dekalb stony loam.
		Hagerstown shale loam	Dekalb shale loam.
		Donegal gravelly loam	Wheeling gravelly loam.
10	Lebanon area, 1901	Cecil clay	Cecil stony loam.
		Edgemont stony loam	Dekalb stony loam.
		Hagerstown shale loam	Dekalb shale loam.
		Dauphin sandy loam	Dekalb sandy loam
		Donegal gravelly loam	Wheeling gravelly loam.
11	Lockhaven area, 1903	Norfolk silt loam	Huntington loam.
		Norfolk loam	Huntington fine sandy loam.
		Hagerstown shale loam	Dekalb shale loam.
12	Montgomery County, 1905	Cecil clay loam	Montalto clay loam.
		Chester mica loam	Manor loam.
		Cecil stony loam	Montalto stony loam.
13	Northeastern Pennsylvania Reconnoissance, 1911.		
14	Northwestern Pennsylvania Reconnoissance, 1908.		
15	South-Central Pennsylvania Reconnoissance, 1910.	Ledy soils	Murrill soils.
16	Southwestern Pennsylvania Reconnoissance, 1909.	Kittanning soils	Wheeling soils.
17	Trenton area, New Jersey, 1902.	Susquehanna gravel	Norfolk gravel.
		Elsinboro fine sand	Sassafras fine sand.
		Sassafras loam	Sassafras silt loam.
		Windsor sand	Norfolk coarse sand.
		Quinton sandy loam	Norfolk sandy loam.
		Cecil loam	Cecil stony loam.
		Westphalia sand	Norfolk fine sand.
18	Washington County, 1910		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

No.	Name of area.	Soil name as published.	Changed to—
	RHODE ISLAND.		
1	Entire State, 1904	Gloucester stony loam	Rough stony land.
		Alton stony loam	Plymouth sandy loam.
		Miami stony loam	Flushing loam.
		Galveston fine sand	Coastal beach.
		Galveston sandy loam	Tidal marsh.
		Norfolk coarse sand	Merrimac coarse sand.
		Warwick sandy loam	Merrimac coarse sandy loam.
		Miami silt loam	Merrimac silt loam.
	SOUTH CAROLINA.		
1	Abbeville area, 1902	Davie clay loam	Louisa fine sandy loam.
2	Anderson County, 1909		
3	Campobello area, 1903	Cecil sand	Durham sandy loam.
4	Charleston area, 1904	Galveston fine sand	Coastal beach.
		Galveston clay	Tidal marsh.
5	Cherokee County, 1905	Cecil silt loam	Louisa silt loam.
		Cecil sand	Durham sandy loam.
		Cecil fine sandy loam	Louisa fine sandy loam.
6	Clarendon County, 1910		
7	Conway area, 1909		
8	Darlington area, 1902	Norfolk sandy soil	Norfolk sandy loam.
		Ayden fine sandy loam	Norfolk fine sandy loam.
		Sassafras loam	Cahaba fine sandy loam.
		Orangeburg loam	Orangeburg sandy loam.
		Goldsboro compact sandy loam	Portsmouth sandy loam.
		Selma heavy silt loam	Do.
9	Fairfield County, 1911		
10	Georgetown County, 1911		
11	Lancaster County, 1904	Cecil fine sandy loam	York fine sandy loam.
		Cecil silt loam	York silt loam.
12	Lee County, 1907		
13	Oconee County, 1907	Pilot loam	Talladega loam.
14	Orangeburg area, 1904	Orangeburg sand	Orangeburg sandy loam.
15	Saluda County, 1909	Durham fine sandy loam	York fine sandy loam.
16	Sumter County, 1907	Orangeburg clay	Greenville clay loam.
		Orangeburg sand	Orangeburg sandy loam.
17	York County, 1905	Cecil sand	Durham sandy loam.
		Cecil fine sandy loam	York fine sandy loam.
		Cecil silt loam	York silt loam.
	SOUTH DAKOTA.		
1	Belle Fourche area, 1907		
2	Brookings area, 1903	Miami black clay loam	Fargo clay loam.
		Marshall loam	Carrington silt loam.
		Marshall sandy loam	Carrington sandy loam.
		Marshall stony loam	Carrington stony loam.
3	Western South Dakota Reconnoissance, 1909		
	TENNESSEE.		
1	Coffee County, 1908	Hillsboro silt loam	Clarksville silt loam.
2	Davidson County, 1903	Clarksville loam	Huntington silt loam.
		Davidson loam	Hagerstown loam.
3	Giles County, 1907	do	Do.
4	Grainger County, 1906	Moccasin stony clay	Hagerstown stony clay.
		Newman stony loam	Hagerstown stony loam.
		Clinch shale loam	Dekalb shale loam.
		Grainger shale loam	Conasauga shale loam.
5	Greeneville area, 1904	Fort Payne stony loam	Clarksville stony loam.
		Fort Payne clay	Conestoga clay.
		Fort Payne loam	Hagerstown loam.
		Decatur clay	Hagerstown clay.
6	Henderson County, 1905		
7	Lawrence County, 1904	Clarksville loam	Huntington silt loam.
		Clarksville clay loam	Hagerstown loam.
8	Madison County, 1906		
9	Montgomery County, 1901	Clarksville loam	Huntington silt loam.
10	Overton County, 1908		
11	Pikeville area, 1903	Clarksville loam	Do.
		Dekalb clay loam	Lickdale clay loam.
12	Sumner County, 1909		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

TEXAS.

No.	Name of area.	Soil name as published.	Changed to—
1	Anderson County, 1904	Houston clay	Houston black clay.
		Yazoo sandy loam	Trinity fine sandy loam.
		Yazoo clay	Trinity clay.
		Orangeburg clay	Greenville clay loam.
2	Austin area, 1904	Austin clay	Houston clay.
		Lufkin fine sandy loam	Susquehanna fine sandy loam.
		Yazoo clay	Trinity clay.
		Colton stony clay	Crawford stony clay.
		Yakima stony clay	Rough stony land.
		Yazoo sandy loam	Bastrop fine sandy loam.
3	Bastrop County, 1907	Wabash clay	Trinity clay.
4	Brazoria area, 1902	Galveston sand	Coastal beach.
		Galveston clay	Tidal marsh.
		Calcasieu fine sandy loam	Caddo fine sandy loam.
		Yazoo clay	Miller clay.
		Yazoo sandy loam	Pledger silt loam.
		Sharkey clay	Trinity clay.
		Houston black clay	Victoria clay.
5	Brownsville area, 1907		
6	Camp County, 1908		
7	Cooper area, 1907	Wabash clay	Trinity clay.
8	Corpus Christi area, 1908	Corpus Christi clay	Do.
9	Ellis County, 1910		
10	Franklin County, 1908	Wabash clay	Do.
		Orangeburg sand	Orangeburg sandy loam.
11	Grayson County, 1909		
12	Central Gulf Coast Texas Reconnoissance, 1910.	Galveston fine sand	Coastal beach.
13	Henderson area, 1906	Orangeburg fine sand	Orangeburg fine sandy loam.
14	Houston County, 1905	Yazoo sandy loam	Trinity sandy loam.
		Wabash clay	Trinity clay.
		Yazoo loam	Trinity loam.
		Orangeburg clay	Greenville clay loam.
15	Jacksonville area, 1903	do	Do.
16	Laredo area, 1906		
17	Lavaca County, 1905		
18	Lee County, 1905	Orangeburg clay	Do.
19	Lufkin area, 1903		
20	Morris County, 1909		
21	Nacogdoches area, 1903	Orangeburg clay	Do.
22	Panhandle Texas Reconnoissance, 1910.		
23	Paris area, 1903	Houston silt loam	Houston loam.
		Houston clay	Do.
		Vernon fine sand	Miller fine sand.
		Orangeburg silt loam	Miller silt loam.
		Orangeburg clay	Greenville clay loam.
24	Robertson County, 1907	Wabash clay	Trinity clay.
		Orangeburg sand	Orangeburg sandy loam.
25	San Antonio area, 1904	Austin clay	Houston clay.
		Norfolk silt loam	Crockett loam.
		Colton stony clay	Crawford stony clay.
		Portsmouth sandy loam	Victoria fine sandy loam.
		Orangeburg clay	Greenville clay loam.
		San Antonio clay loam	San Antonio silty clay loam.
26	San Marcos area, 1906	Wabash clay	Trinity clay.
		Crawford silt clay	San Antonio silty clay.
27	South Texas Reconnoissance, 1909.	Galveston fine sand	Coastal beach.
28	Southwestern Texas Reconnoisance, 1911.		
29	Titus County, 1909		
30	Vernon area, 1902	Vernon silt loam	Miller silt loam.
		Vernon loam	Vernon silt loam.
31	Waco area, 1905	Miller heavy clay	Miller clay.
		Yazoo heavy clay	Trinity clay.
		Yazoo clay	Do.
32	Willis area, 1901	San Jacinto clay	Houston black clay.
		Willis sand	Norfolk fine sandy loam.
33	Wilson County, 1907	Wabash clay	Trinity clay.
		Webb loam	Duval loam.
34	Woodville area, 1903		

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

UTAH.

No.	Name of area.	Soil name as published.	Changed to—
1	Bear River area, 1904	Jordan loam	Jordan clay loam.
		Bingham gravelly loam	Bingham gravelly sandy loam.
		Malade fine sand	Jordan fine sand.
		Fresno fine sandy loam	Jordan fine sandy loam.
		Malade loam	Jordan loam.
		Malade sandy loam	Jordan sandy loam.
		Malade fine sandy loam	Jordan fine sandy loam.
2	Provo area, 1903	Maricopa stony loam	Bingham stony loam.
		Jordan sandy loam	Jordan loam.
		Jordan loam	Jordan clay loam.
		Maricopa gravelly loam	Bingham gravelly sandy loam.
		Fresno sand	Bingham sand.
		Salt Lake sand	Oolitic sand.
3	Salt Lake Valley, 1899	Jordan sand	Jordan fine sand.
		Jordan sandy loam	Jordan fine sandy loam.
		Jordan meadows	Meadow.
		Jordan clay	Salt Lake clay loam
		Bingham gravelly loam	Bingham gravelly sandy loam.
		Salt Lake sand	Oolitic sand.
4	Sevier Valley, 1900	Elsinore sandy loam	Elsinore fine sandy loam.
		Redfield sandy loam	Redfield fine sandy loam.
		Bingham gravelly loam	Bingham gravelly sandy loam.
		Glenwood loam	Bingham clay loam.
5	Weber County, 1900	Fresno sand	Bingham sand.
		Jordan loam	Bingham loam.
		Jordan sand	Bingham fine sand.
		Fresno fine sandy loam	Bingham fine sandy loam.

VERMONT.

1	Vergennes area, 1904	Alton stony loam	Adirondack stony sandy loam.

VIRGINIA.

1	Albemarle area, 1902	Cecil loam	Chester loam.
		Edgemont stony loam	Dekalb stony loam.
		Hagerstown shale loam	Dekalb shale loam.
		Conowingo barrens	Barrens (Conowingo material).
2	Appomattox County, 1904	Cecil loam	York loam.
		Cecil sand	Durham sandy loam.
3	Bedford area, 1901	Hagerstown shale loam	Dekalb shale loam.
		Porters red clay	Porters clay.
		Murrill stony loam	Hagerstown stony loam.
		Murrill sandy loam	Hagerstown sandy loam.
4	Campbell County, 1909		
5	Chesterfield County, 1906		
6	Hanover County, 1905	Cecil sand	Durham sandy loam.
7	Leesburg area, 1903	Loudoun sandy loam	Chester sandy loam.
		Cecil mica loam	Manor loam.
		Cecil loam	Chester loam.
		Cecil silt loam	Lansdale silt loam.
		Hagerstown shale loam	Dekalb shale loam.
8	Louisa County, 1905	Cecil sand	Durham sandy loam.
		Cecil fine sandy loam	Louisa fine sandy loam.
		Cecil loam	Louisa loam.
9	Montgomery County, 1907	Pilot gravelly loam	Talladega gravelly loam.
		Pilot loam	Talladega loam.
		Radford loam	Cumberland loam.
		Indian loam	Chandler loam.
10	Norfolk area, 1903	Galveston sand	Coastal beach.
		Norfolk sand	Norfolk fine sand.
		Leonardtown gravelly loam	Portsmouth silt loam.
		Leonardtown loam	Do.
		Norfolk loam	Sassafras sandy loam.
11	Prince Edward area, 1901		
12	Yorktown area, 1905	Galveston sand	Coastal beach.
		Galveston clay	Tidal marsh.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

WASHINGTON.

No.	Name of area.	Soil name as published.	Changed to—
1	Bellingham area, 1907		
2	Everett area, 1905		
3	Island County, 1905		
4	Puget Sound Basin, eastern part, Washington reconnoissance, 1909.		
5	Puget Sound Basin, western part, Washington, reconnoissance, 1910.	Everett stony loams	Everett stony loam.
		Olympia loams	Olympia loam.
6	Quincy area, 1911		
7	Southwestern Washington reconnoissance, 1911.		
8	Walla Walla area, 1902	Walla Walla loam	Walla Walla silt loam.
		Yakima fine sandy loam	Do.
		Yakima sandy loam	Do.
		Yakima loam	Caldwell loam.
		Yakima gravelly loam	Caldwell gravelly loam.
9	Yakima area, 1901	Yakima sandy loam	Yakima fine sandy loam.
		Sunnyside sand	Quincy fine sand.
		Yakima stony loam	Quincy fine sandy loam.

WEST VIRGINIA.

No.	Name of area.	Soil name as published.	Changed to—
1	Clarksburg area, 1910		
2	Huntington are, 1911		
3	Leesburg area, Virginia, 1903	Loudoun sandy loam	Chester sandy loam.
		Cecil mica loam	Manor loam.
		Cecil loam	Chester loam.
		Cecil silt loam	Lansdale silt loam.
		Hagerstown shale loam	Dekalb shale loam.
4	Middlebourne area, 1907		
5	Morgantown area, 1911		
6	Parkersburg area, 1908		
7	Point Pleasant area, 1910		
8	Spencer area, 1909		
9	Upshur County, 1905		
10	Wheeling area, 1906		

WISCONSIN.

No.	Name of area.	Soil name as published.	Changed to—
1	Bayfield area, 1910		
2	Carlton area, Minnesota, 1905	Miami gravelly sandy loam	Coloma gravelly sandy loam.
		Miami fine sand	Coloma fine sand.
		Miami sandy loam	Coloma sandy loam.
		Miami stony loam	Miami loam.
		Miami sand	Coloma sand.
		Barnum loam	Kewaunee loam.
		Barnum stony loam	Kewaunee stony loam.
3	Columbia County, 1911		
4	Fond du Lac County, 1911	Superior gravelly loam	Kewaunee gravelly loam.
5	Iowa County, 1910		
6	Janesville area, 1902	Miami loam	Sioux sandy loam.
		Edgerton silt loam	Miami silt loam.
		Janesville silt loam	Carrington silt loam.
		Miami black clay loam	Do.
		Mackinaw gravel	Judson gravel.
		Hanover sand	Coloma sandy loam.
		Janesville loam	Plainfield silt loam.
		Afton fine sandy loam	Plainfield sand.
7	Juneau County, 1911		
8	Kewaunee County, 1911		
9	La Crosse County, 1911		
10	Marinette County reconnoissance, 1909.		
11	Portage County, 1905	Miami stony sand	Coloma stony sand.
		Miami sandy loam	Coloma sandy loam.
		Miami stony loam	Miami loam.
		Miami sand	Coloma sand.
		Marshall sand	Plainfield sand.
		Marshall gravelly loam	Waukesha sandy loam.
12	Racine County, 1906	Miami gravel	Coloma gravel.
		Marshall clay loam	Carrington clay loam.
		Sioux sandy loam	Dunkirk sandy loam.
		Marshall loam	Carrington loam.

Areas surveyed and changes which have been made in the correlation of the soils since the reports were published—Continued.

WISCONSIN—Continued.

No.	Name of area.	Soil name as published.	Changed to—
13	Superior area, 1904	Miami sandy loam	Coloma sandy loam.
		Miami sand	Coloma sand.
14	Viroqua area, 1903	Miami loam	Wabash loam.
		Miami silt loam	Knox silt loam.
		Miami sand	Boone sand.
		Miami sandy loam	Boone sandy loam.
15	Waukesha County, 1910		
16	Waushara County, 1909		

WYOMING.

No.	Name of area.	Soil name as published.	Changed to—
1	Laramie area, 1903	Billings clay	Bent clay.
		Redfield sandy loam	Albany fine sandy loam.
		Laramie gravelly loam	Laramie gravelly sandy loam.
		Laramie sandy loam	Laramie fine sandy loam.
		Laurel sandy loam	Grand sandy loam.

APPENDIX B.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered.

Name as published.	Changed to—	Name of area.
Afton fine sandy loam	Plainfield sand	Janesville area, Wis.
Allegan black clay	Clyde loam	Allegan County, Mich.
Allegan clay	Miami clay loam	Do.
Allegan fine sandy loam	Coloma fine sand	Do.
Allegan gravelly loam	Coloma gravelly sand	Do.
	Coloma gravelly sandy loam	Pontiac area, Mich.
Allegan sand	Coloma sand	Allegan County, Mich.
Allegan sandy loam	Coloma sandy loam	Do.
Allegan stony loam	Miami loam	Do.
Alloway clay	Dunkirk clay	Lyons area, N. Y.
		Syracuse area, N. Y.
Almyra silt loam	Crowley silt loam	Stuttgart area, Ark.
Alton stony loam	Adirondack stony sandy loam	Vergennes area, Vt.
	Dunkirk stony loam	Lyons area, N. Y.
	Ontario stony loam	Syracuse area, N. Y.
	Plymouth sandy loam	Long Island area, N. Y.
		Rhode Island.
Alviso clay	Tidal marsh	Pajaro Valley, Cal.
Amory fine sandy loam	Cahaba fine sandy loam	Monroe County, Miss.
Arkansas fine sandy loam	Wabash fine sandy loam	Stanton area, Nebr.
Arnold sandy loam	Siskiyou sandy loam	Modesto-Turlock area, Cal.
Arroyo Seco sandy loam	Maricopa gravelly loam	Lower Salinas Valley area, Cal.
		San Jose area, Cal.
Austin clay	Houston clay	Austin area, Tex.
		San Antonio area, Tex.
Ayden fine sandy loam	Norfolk fine sandy loam	Darlington area, S. C.
Barnum loam	Kewaunee loam	Carlton area, Minn.
Barnum stony loam	Kewaunee stony loam	Do.
Benoit loam	Fargo loam	Crookston area, Minn.
Benton loam	Benton stony loam	Russell area, Kans.
Billings clay	Bent clay	Laramie area, Wyo.
	Wade clay	Billings area, Mont.
Billings clay loam	Wade clay loam	Greeley area, Colo.
Billings gravelly loam	Wade gravelly loam	Billings area, Mont.
Billings loam	Wade loam	Greeley area, Colo.
	Wade clay loam	Billings area, Mont.
Billings sandy loam	Wade fine sandy loam	Do.
Billings silt loam	Wade silt loam	Greeley area, Colo.
Bingham gravelly loam	Bingham gravelly sandy loam	Salt Lake Valley, Utah.
		Sevier Valley, Utah.
		Bear River area, Utah.
Bloomfield sandy loam	Knox sandy loam	Greene County, Ind.
Boise sandy loam	Boise silt loam	Boise area, Idaho.
Brandywine loam	Manor loam	Chester County, Pa.
Calcasieu fine sand	Caddo fine sand	Lake Charles area, La.
Calcasieu fine sandy loam	Caddo fine sandy loam	Do.
		Brazoria area, Tex.
Calcasieu loam	Caddo loam	Lake Charles area, La.
Caldwell loam	Caldwell silt loam	Boise area, Idaho.
Caldwell sandy loam	Caldwell fine sandy loam	Do.
Carrington clay loam	Wabash clay loam	Carrington area, N. Dak.
Carver coarse sandy loam	Merrimac coarse sandy loam	Plymouth County, Mass.
Carver fine sandy loam	Merrimac fine sandy loam	Do.
Carver gravelly sandy loam	Merrimac gravelly sandy loam	Do.
Carver sandy loam	Merrimac sandy loam	Do.
Cassadaga sand	Meadow	Westfield area, N. Y.
Caswell sandy loam	Rough gullied land	Caswell County, N. C.
Cecil clay	Cecil stony loam	Lebanon area, Pa.
Cecil clay loam	Montalto clay loam	Adams County, Pa.
		Montgomery County, Pa.
Cecil fine sandy loam	Louisa fine sandy loam	Cherokee County, S. C.
		Louisa County, Va.
	York fine sandy loam	Lancaster County, S. C.
		York County, S. C.
Cecil loam	Cecil stony loam	Trenton area, N. J.
	Chester loam	Cecil County, Md.
		Harford County, Md.
		Leesburg area, Va.
		Adams County, Pa.
		Albemarle County, Va.
	York loam	Appomattox County, Va.
	Louisa loam	Louisa County, Va.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Cecil mica loam	Manor loam	Cecil County, Md.
		Harford County, Md.
		Leesburg area, Va.
		Prince George County, Md.
		Lancaster area, Pa.
Cecil sand	Durham sandy loam	Spalding County, Ga.
		Campobello area, S. C.
		Cherokee County, S. C.
		York County, S. C.
		Appomattox County, Va.
		Hanover County, Va.
		Louisa County, Va.
Cecil silt loam	Lansdale silt loam	Leesburg area, Va.
	Louisa silt loam	Cherokee County, S. C.
	York silt loam	York County, S. C.
		Lancaster County, S. C.
Cecil slate loam	Louisa slate loam	Tallapoosa County, Ala.
Cecil stony loam	Montalto stony loam	Montgomery County, Pa.
		Adams County, Pa.
Chattooga loam	Holston loam	Fort Payne area, Ala.
Chemung stony loam	Chemung shale loam	Johnstown area, Pa.
Chester mica loam	Manor loam	Montgomery County, Pa.
Chicopee gravel loam	Merrimac gravelly sandy loam	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Clarksville clay	Elk clay	Huntsville area, Ala.
Clarksville clay loam	Hagerstown loam	Lauderdale County, Ala.
		Lawrence County, Tenn.
Clarksville loam	Huntington silt loam	Fort Payne area, Ala.
		Lauderdale County, Ala.
		Warren County, Ky.
		Webster County, Mo.
		Davidson County, Tenn.
		Lawrence County, Tenn.
		Montgomery County, Tenn.
		Pikeville area, Tenn.
	Wabash silt loam	Howell County, Mo.
		Saline County, Mo.
Clarksville stony loam	Rough stony land	Dubuque area, Iowa.
		Wichita area, Kans.
Clinch shale loam	Dekalb shale loam	Grainger County, Tenn.
Clyde loam	Fargo loam	Cando area, N. Dak.
Colorado adobe	Laurel loam adobe	Garden City area, Kans.
	Benton loam adobe	Greeley area, Colo.
Colorado fine sandy loam	Benton fine sandy loam	Do.
Colorado loam	Benton loam	Do.
Colorado sand	Richfield sand	Garden City area, Kans.
Colton stony clay	Crawford stony clay	Austin area, Tex.
		San Antonio area, Tex.
Congaree clay	Huntington clay	Montgomery County, Ala.
Congaree loam	Ocklocknee loam	Do.
Connecticut meadows	Podunk silt loam	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Connecticut swamp	Swamp	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Conowingo barrens	Barrens (Conowingo material)	Cecil County, Md.
		Harford County, Md.
		Chester County, Pa.
		Albemarle area, Va.
Contra Costa sandy loam	Sites sandy loam	Livermore area, Cal.
Corpus Christi clay	Trinity clay	Corpus Christi area, Tex.
Crawford silty clay	San Antonio silty clay	San Marcos area, Tex.
Dauphin sandy loam	Dekalb sandy loam	Lebanon area, Pa.
Davidson loam	Hagerstown loam	Davidson County, Tenn.
		Giles County, Tenn.
Davie clay loam	Louisa fine sandy loam	Abbeville area, S. C.
	Louisa loam	Statesville area, N. C.
Decatur clay	Hagerstown clay	Greeneville area, Tenn.
Deer Flat sandy loam	Deer Flat fine sandy loam	Boise area, Idaho.
Dekalb clay loam	Lickdale clay loam	Pikeville area, Tenn.
Delavan silt loam	Plainfield silt loam	Tazewell County, Ill.
Donegal gravelly loam	Wheeling gravelly loam	Lancaster area, Pa.
		Lebanon area, Pa.
Dunkirk fine sandy loam	Chenango fine sandy loam	Binghamton area, N. Y.
Dunkirk gravelly loam	Dunkirk gravelly sandy loam	Ashtabula area, Ohio.
		Westfield area, N. Y.
	Chenango gravelly loam	Binghamton area, N. Y.
		Big flats area, N. Y.
Dunkirk gravelly sandy loam	Chenango gravelly sandy loam	Binghamton area, N. Y.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Dunkirk sandy loam	Dunkirk fine sandy loam	Ashtabula area, Ohio.
		Westfield area, N. Y.
Dunkirk shale loam	Volusia shale loam	Do.
	Chenango shale loam	Binghamton area, N. Y.
		Big flat area, N. Y.
Dunkirk silt loam	Chenango silt loam	Binghamton area, N. Y.
		Big flats area, N. Y.
Durham fine sandy loam	York fine sandy loam	Saluda County, S. C.
Edgemont stony loam	Dekalb stony loam	Lancaster area, Pa.
		Lebanon area, Pa.
		Albemarle area, Va.
Edgerton silt loam	Miami silt loam	Clinton County, Ill.
		Janesville area, Wis.
Elkhorn silt loam	Wabash silt loam	Stanton area, Nebr.
Elkton clay	Elkton silt loam	Dover area, Del.
		Cecil County, Md.
		Harford County, Md.
		Kent County, Md.
		Prince George County, Md.
		Worcester County, Md.
		Salem area, N. J.
	Holly clay loam	Mason County, Ky.
Elmira fine sandy loam	Genesee fine sandy loam	Bigflats area, N. Y.
Elmira shale loam	Chenango shale loam	Do.
Elmira silt loam	Chenango silt loam	Do.
	Dunkirk silt loam	Lyons area, N. Y.
Elmwood loam	Suffield loam	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Elsinboro fine sand	Sassafras fine sand	Trenton area, N. J.
	Sassafras fine sandy loam	Salem area, N. J.
Elsinore sandy loam	Elsinore fine sandy loam	Sevier Valley, Utah.
Encina sandy loam	Melbourne sandy loam	Pajaro Valley area, Cal.
Enfield sandy loam	Manchester fine sand	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Everett stony loams	Everett stony loam	Puget Sound Basin, western part, Wash.
Fairview sandy loam	Marshall sandy loam	Marshall area, Minn.
Fancher sandy loam	Hanford sandy loam	Hanford area, Cal.
	Fancher fine sandy loam	Fresno area, Cal.
Fargo gravelly loam	Carrington gravelly loam	Grand Forks area, N. Dak.
Fernley fine sand	Lahontan fine sand	Fallon area, Nev.
Finney clay	Hoisington clay	Garden City area, Kans.
	Fargo clay	Williston area, N. Dak.
Fort Payne clay	Conestoga clay	Greeneville area, Tenn.
Fort Payne loam	Hagerstown loam	Do.
Fort Payne sandy loam	Cossayuna fine sandy loam	Munising area, Mich.
Fort Payne stony loam	Clarksville stony loam	Blount County, Ala.
		Fort Payne area, Ala.
		Greeneville area, Tenn.
Fresno clay loam	Modesto clay loam	Madera area, Cal.
Fresno fine sand	Hanford fine sand	Bakersfield area, Cal.
		Los Angeles area, Cal.
	Laurel fine sand	Lower Arkansas Valley, Colo.
	Sacramento fine sandy loam	Sacramento area, Cal.
Fresno fine sandy loam	Hanford fine sandy loam	Bakersfield area, Cal.
		Los Angeles area, Cal.
		Lower Salinas Valley, Cal.
		San Bernardino area, Cal.
		San Gabriel area, Cal.
		Santa Ana area, Cal.
	Indio fine sandy loam	Indio area, Cal.
	Oxnard loam	Ventura area, Cal.
	Benton silt loam	Lower Arkansas Valley, Colo.
	Bingham fine sandy loam	Weber County, Utah.
	Jordan fine sandy loam	Bear River area, Utah.
	Livermore silt loam	San Jose area, Cal.
Fresno gravel	Riverwash	Sacramento area, Cal.
Fresno gravelly sand	Glendale sand	Yuma area, Ariz.
Fresno red sand	San Joaquin sand	Fresno area, Cal.
		Sacramento area, Cal.
Fresno sand	Colorado sand	Lower Arkansas Valley, Colo.
	Hanford sand	Bakersfield area, Cal.
		Los Angeles area, Cal.
		Lower Salinas Valley, Cal.
		San Bernardino area, Cal.
		San Gabriel area, Cal.
		Santa Ana area, Cal.
	Indio sand	Indio area, Cal.
	Maricopa sand	Ventura area, Cal.
	Bingham sand	Provo area, Utah.
		Weber area, Utah.
	Columbia sand	Sacramento area, Cal.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Fresno sandy loam	Fresno fine sandy loam	Fresno area, Cal.
		Hanford area, Cal.
	Indio fine sand	Indio area, Cal.
Fullerton sandy adobe	Placentia clay loam adobe	Ventura area, Cal.
	Maricopa loam adobe	Los Angeles area, Cal.
		San Bernardino area, Cal.
	Placentia sandy loam adobe	Santa Ana area, Cal.
Galveston clay	Tidal marsh	Dover area, Del.
		New Orleans, La.
		Worcester County, Md.
		Long Island area, N. Y.
		Charleston area, S. C.
		Brazoria area, Tex.
		Yorktown area, Va.
		New Hanover County, N. C.
		Los Angeles area, Cal.
		San Jose area, Cal.
Galveston fine sand	Coastal beach	New Hanover County, N. C.
		Rhode Island.
		Charleston area, S. C.
		Central Gulf Coast, Tex.
		South Texas Reconnoissance.
Galveston sand	do.	Dover area, Del.
		Escambia County, Fla.
		Worcester County, Md.
		Long Island area, N. Y.
		New Hanover County, N. C.
		Brazoria area, Tex.
		Norfolk area, Va.
		Yorktown area, Va.
Galveston sandy loam	Tidal marsh	Long Island area, N. Y.
		Rhode Island.
Garner stony loam	Susquehanna gravelly loam	Raleigh to Newbern, N. C.
Gila fine sandy loam	Gila loam	Solomonsville area, Ariz.
		Imperial area, Cal.
Glenwood loam	Bingham clay loam	Sevier Valley, Utah.
Glendale loess	Glendale clay loam	Salt River Valley, Ariz.
Gloucester stony loam	Rough stony land	Rhode Island.
Goldsboro compact sandy loam	Portsmouth sandy loam	Raleigh to Newbern, N. C.
		Darlington area, S. C.
Grainger shale loam	Conasauga shale loam	Grainger County, Tenn.
Guin fine sandy loam	Ruston fine sandy loam	Hale County, Ala.
		Lamar County, Ala.
		Marion County, Ala.
		Monroe County, Miss.
		Prentiss County, Miss.
Guin gravelly sandy loam	Ruston gravelly sandy loam	Autauga Couunty, Ala.
Guthrie clay	Waverly clay loam	Posey County, Ind.
	Waverly silt loam	Stuttgart area, Ark.
Hagerstown shale loam	Dekalb shale loam	Lancaster area, Pa.
		Lebanon area, Pa.
		Lock Haven area, Pa.
		Albemarle area, Va.
		Bedford area, Va.
		Leesburg area, Va.
	Volusia silt loam	Bigflats area, N. Y.
Hagerstown silt loam	Clarksville silt loam	Huntsville area, Ala.
Hanford silt loam	Merced silty clay loam	Modesto-Turlock area, Cal.
Hanover sand	Coloma sandy loam	Janesville area, Wis.
Hempfield stony loam	Cecil stony loam	Lancaster area, Pa.
Herndon stony loam	Porters stony loam	Cobb County, Ga.
		Alamance County, N. C.
		Statesville area, N. C.
Hillsboro silt loam	Clarksville silt loam	Coffee County, Tenn.
Hobart clay	Rough broken land	Carrington area, N. Dak.
		Jamestown area, N. Dak.
Hondo meadows	Meadow	Pecos Valley area, N. Mex.
Houston black clay	Victoria clay	Brazoria area, Tex.
	Houston clay	Macon County, Ala.
Houston chalk	Chalk (Houston material)	Autauga County, Ala.
		Clay County, Miss.
		Lowndes County, Miss.
		Monroe County, Miss.
		Noxubee County, Miss.
		Oktibbeha County, Miss.
Houston clay	Houston black clay	Anderson County, Tex.
	Houston loam	Paris area, Tex.
Houston silt loam	do.	Do.
Huntington fine sandy loam	Wabash loam	Greene County, Ind.
Huntington loam	Genesee loam	Madison County, N. Y.
		Niagara County, N. Y.
	Wabash loam	Marion County, Ind.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Huntington silt loam	Ondawa silt loam	Dutchess County, N. Y.
	Wabash silt loam	Greene County, Ind.
Hyde mucky loam	Muck (Hyde mucky loam)	Lake Mattamuskeet area, N. C.
Imperial fine sandy loam	Gila loam	Yuma area, Ariz.
Imperial gravelly loam	Indio gravelly loam	Imperial area, Cal.
Imperial loam	Gila clay loam	Yuma area, Ariz.
	Imperial clay loam	Imperial area, Cal.
Imperial sand	Gila fine sand	Yuma area, Ariz.
Imperial sandy loam	Gila fine sandy loam	Do.
Imperial silt loam	Gila silt loam	Do.
Indian loam	Chandler loam	Montgomery County, Va.
Janesville loam	Plainfield silt loam	Janesville area, Wis.
Janesville silt loam	Carrington silt loam	Do.
Jordan clay	Salt Lake clay loam	Salt Lake Valley, Utah.
Jordan loam	Jordan clay loam	Provo area, Utah.
		Bear River area, Utah.
	Bingham loam	Weber area, Utah.
Jordan meadows	Meadow	Salt Lake Valley, Utah.
Jordan sand	Jordan fine sand	Do.
	Bingham fine sand	Weber area, Utah.
Jordan sandy loam	Jordan loam	Provo area, Utah.
	Jordan fine sandy loam	Salt Lake Valley, Utah.
Kalamazoo gravelly loam	Clyde gravelly sand	Allegan County, Mich.
Kaskaskia loam	Wabash silt loam	Clinton County, Ill.
		Knox County, Ill.
		McLean County, Ill.
		Sangamon County, Ill.
		St. Clair County, Ill.
		Newton County, Ind.
		Tama County, Iowa.
King clay	Colbert clay	Colbert County, Ala.
King clay loam	Colbert clay loam	Do.
Kittanning soils	Wheeling soils	Southwestern Pennsylvania.
Laramie gravelly loam	Laramie gravelly sandy loam	Laramie area, Wyo.
Laramie sandy loam	Laramie fine sandy loam	Do.
Laurel fine sand	Arkansas fine sand	Riley County, Kans.
	Grand fine sand	Grand Junction area, Colo.
Laurel fine sandy loam	Arkansas fine sandy loam	Riley County, Kans.
		Atchison County, Mo.
Laurel loam	Grand loam	Uncompahgre Valley area, Colo.
Laurel sandy loam	Grand sandy loam	Grand Junction area, Colo.
		Larmie area, Wyo.
Laurel silt loam	Arkansas silt loam	Riley County, Kans.
Laurel silty clay loam	Grand silty clay loam	Uncompahgre Valley area, Colo.
Ledy soils	Murrill soils	South-central Pennsylvania.
Leighton loam	Clarksville loam	Colbert County, Ala.
Leonardtown gravelly loam	Leonardtown loam	Prince George County, Md.
	Portsmouth silt loam	Norfolk area, Va.
Leonardtown loam	do	Do.
	Huntington silt loam	Mason County, Ky.
Lewis clay loam	Yolo clay loam	Portersville area, Cal.
Lincoln sandy loam	Laurel fine sandy loam	Russell area, Kans.
Lintonia loam	Lintonia silt loam	St. Clair County, Ill.
		Holmes County, Miss.
		Montgomery County, Miss.
		Smedes area, Miss.
		Yazoo area, Miss.
	Wabash loam	Tazewell County, Ill.
	Wabash silt loam	Dubuque area, Iowa.
Los Angeles sandy loam	Altamont loam	Los Angeles area, Cal.
Loudoun sandy loam	Chester sandy loam	Leesburg area, Va.
Lufkin clay	Susquehanna clay	Macon County, Ala.
Lufkin clay loam	Lufkin clay	Sumter County, Ala.
Lufkin fine sandy loam	Susquehanna fine sandy loam	Austin area, Tex.
McLean silt loam	Marshall loam	McLean County, Ill.
McLeod sand	Dunkirk sand	Crookston area, Minn.
		Ransom County, N. Dak.
Mackinaw gravel	Judson gravel	Tazewell County, Ill.
		Janesville area, Wis.
Madison loam	Sioux clay loam	Madison County, Ind.
Malade fine sand	Jordan fine sand	Bear River area, Utah.
Malade fine sandy loam	Jordan fine sandy loam	Do.
Malade loam	Jordan loam	Do.
Malade sandy loam	Jordan sandy loam	Do.
Mankato sand	Sioux sand	Blue Earth County, Minn.
Marco clay loam	Wabash clay loam	Greene County, Ind.
Marco fine sandy loam	Lintonia fine sandy loam	Do.
Maricopa clay loam	Colorado clay loam	Lower Arkansas Valley, Colo.
	Glendale clay loam	Salt River Valley, Ariz.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Maricopa gravelly loam	Maricopa fine sandy loam	Los Angeles area, Cal.
	Glendale gravelly loam	Salt River Valley, Ariz.
	Bingham gravelly sandy loam	Provo area, Utah.
	Hutchinson gravelly loam	Baker City area, Oreg.
	Glendale loam	Solomonsville area, Ariz.
Maricopa loam	Fresno loam	Bakersfield area, Cal.
	Glendale loam	Salt River Valley, Ariz.
Maricopa sand	Colorado sand	Lower Arkansas Valley, Colo.
	Glendale sand	Solomonsville area, Ariz.
Maricopa sandy adobe	Benton loam adobe	Lower Arkansas Valley, Colo.
	Placentia sandy loam adobe	Bakersfield area, Cal.
Maricopa sandy loam	Colorado sandy loam	Lower Arkansas Valley, Colo.
	Maricopa gravelly loam	San Bernardino area, Cal.
	Glendale sandy loam	Solomonsville area, Ariz.
	Hutchinson loam	Baker City area, Oreg.
	Glendale fine sandy loam	Salt River Valley, Ariz.
Maricopa silt loam	Glendale silt loam	Solomonsville area, Ariz.
Maricopa stony loam	Bingham stony loam	Provo area, Utah.
Marshall clay	Fargo clay	Fargo area, N. Dak.
Marshall clay loam	Carrington clay loam	Cerro Gordo County, Iowa.
		Story County, Iowa.
		Blue Earth County, Minn.
		Ransom County, N. Dak.
		Racine County, Wis.
Marshall fine sand	Waukesha sand	Newton County, Ind.
Marshall fine sandy loam	Carrington fine sandy loam	Blue Earth County, Minn.
		Ransom County, N. Dak.
		Newton County, Ind.
Marshall gravel	Coloma gravelly sand	Pontiac area, Mich.
	Carrington gravel	Marshall area, Minn.
		Cando area, N. Dak.
Marshall gravelly loam	Carrington gravelly loam	Brown County, Kans.
		Marshall area, Minn.
		Carrington area, N. Dak.
		Ransom area, N. Dak.
	Fargo gravelly loam	Fargo area, N. Dak.
	Waukesha sandy loam	Portage County, Wis.
Marshall gravelly sandy loam	Carrington gravelly sandy loam	Richland County, N. Dak.
Marshall loam	Carrington loam	Racine County, Wis.
		Marshall County, Ind.
		Newton County, Ind.
		Cerro Gordo County, Iowa.
		Story County, Iowa.
		Tama County, Iowa.
		Cass County, Mich.
		Blue Earth County, Minn.
		Marshall County, Minn.
		Lancaster County, Nebr.
		Cando area, N. Dak.
		Carrington area, N. Dak.
		Jamestown area, N. Dak.
		Richland County, N. Dak.
	Carrington silt loam	Brookings area, S. Dak.
		Tippecanoe County, Ind.
	Fargo loam	Fargo area, N. Dak.
Marshall sand	Plainfield sand	Portage County, Wis.
	Waukesha sand	Marshall County, Ind.
		Cerro Gordo County, Iowa.
Marshall sandy loam	Carrington sandy loam	Brown County, Kans.
		Brookings area, S. Dak.
	Waukesha sandy loam	Marshall County, Ind.
	Sioux sandy loam	Marshall area, Minn.
Marshall silt loam	Carrington silt loam	Blue Earth County, Minn.
		Carrington area, N. Dak.
		Jamestown area, N. Dak.
	Richfield silt loam	Garden City area, Kans.
Marshall stony loam	Carrington stony loam	Carrington area, N. Dak.
		Jamestown area, N. Dak.
		Ransom County, N. Dak.
		Brookings area, S. Dak.
Media clay adobe	Sierra clay adobe	Madera area, Cal.
Media coarse sandy loam	Sierra coarse sandy loam	Do.
Media fine sandy loam	Sierra fine sandy loam	Do.
Media sandy loam	Sierra sandy loam	Do.
Memphis silt loam	Lintonia silt loam	Posey County, Ind.
		Union County, Ky.
Merrimac gravelly loam	Fox gravelly loam	Dutchess County, N. Y.
Merrimac gravelly sandy loam	Fox gravelly sandy loam	Do.
Merrimac loam	Fox loam	Do.
Mesa clay	Chipeta clay	Grand Junction area, Colo.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Miami black clay loam	Carrington black clay loam	Allen County, Ind.
		Madison County, Ind.
		Marion County, Ind.
		Marshall County, Ind.
		Newton County, Ind.
		Cerro Gordo area, Iowa.
		Oxford area, Mich.
		Pontiac area, Mich.
		Jamestown area, N. Dak.
		Auglaize County, Ohio.
		Columbus area, Ohio.
		Montgomery County, Ohio.
		Westerville area, Ohio.
	Carrington silt loam	Janesville area, Wis.
	Clyde clay	Toledo area, Ohio.
	Fargo clay loam	Fargo area, N. Dak.
		Brookings area, S. Dak.
	Fargo loam	Marshall area, Minn.
	Fargo silt loam	Grand Forks area, N. Dak.
	Marshall black clay loam	Knox County, Ill.
		McLean County, Ill.
		Sangamon County, Ill.
		Tazewell County, Ill.
		Tippecanoe County, Ind.
	Wabash clay loam	Story County, Iowa.
Miami clay loam	Crowley silt loam	Stuttgart area, Ark.
	Dunkirk clay loam	Toledo area, Ohio.
Miami fine sand	Coloma fine sand	Winnebago County, Ill.
		Cass County, Mich.
		Carlton area, Minn.
	Dunkirk fine sand	Newton County, Ind.
		Owosso area, Mich.
		Saginaw area, Mich.
		Auburn area, N. Y.
		Lyons area, N. Y.
		Madison County, N. Y.
		Syracuse area, N. Y.
	Knox fine sand	Sangamon County, Ill.
		Tazewell County, Ill.
		Tippecanoe County, Ind.
		Tama County, Iowa.
		Stanton area, Nebr.
	Lintonia fine sand	O'Fallon area, Mo.
		Dubuque area, Iowa.
	Arkansas fine sand	Wichita area, Kans.
Miami fine sandy loam	Coloma fine sandy loam	Cass County, Mich.
	Dunkirk fine sandy loam	Lyons area, N. Y.
		Madison County, N. Y.
		Syracuse area, N. Y.
	Knox fine sandy loam	Tippecanoe County, Ind.
	Lintonia fine sandy loam	Boonville area, Ind.
	Memphis silt loam	St. Clair County, Ill.
	Waverly fine sandy loam	Union County, Ky.
		Posey County, Ind.
Miami gravel	Coloma gravel	Racine County, Wis.
	Judson gravel	Winnebago County, Ill.
Miami gravelly loam	Chenango gravelly loam	Marion County, Ind.
		Pontiac area, Mich.
		Columbus area, Ohio.
		Coshocton County, Ohio.
		Montgomery County, Ohio.
		Westerville area, Ohio.
		Wooster area, Ohio.
		Bigflats area, N. Y.
	Dunkirk gravelly loam	Syracuse area, N. Y.
Miami gravelly sand	Coloma gravelly sand	Oxford area, Mich.
	Coloma gravelly sandy loam	Alma area, Mich.
	Dunkirk gravelly sand	Saginaw area, Mich.
		Owosso area, Mich.
Miami gravelly sandy loam	Coloma gravelly sandy loam	Marshall County, Ind.
		Tippecanoe County, Ind.
		Cass County, Mich.
		Oxford area, Mich.
		Carlton area, Minn.
Miami loam	Fargo fine sandy loam	Fargo area, N. Dak.
	Fargo loam	Grand Forks area, N. Dak.
	Genesee loam	Auburn area, N. Y.
		Lyons area, N. Y.
		Syracuse area, N. Y.
	Miami silt loam	Tippecanoe County, Ind.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Miami loam (continued)	Sioux loam	Tazewell County, Ill.
		Marion County, Ind.
	Sioux sandy loam	Janesville area, Wis.
	Wabash loam	Pontiac area, Mich.
		Marshall area, Minn.
		Columbus area, Ohio.
		Coshocton County, Ohio.
		Montgomery County, Ohio.
		Toledo area, Ohio.
		Westerville area, Ohio.
		Viroqua area, Wis.
Miami sand	Coloma fine sand	Oxford area, Mich.
	Coloma sand	Marshall County, Ind.
		Alma area, Mich.
		Cass County, Mich.
		Munising area, Mich.
		Pontiac area, Mich.
		Saginaw area, Mich.
		Wexford County, Mich.
		Carlton area, Minn.
		Wooster area, Ohio.
		Portage County, Wis.
		Superior area, Wis.
	Plainfield sand	Owosso area, Mich.
	Dunkirk sand	Toledo area, Ohio.
	Knox sand	Greene County, Ind.
		Posey County, Ind.
		Grand Island area, Nebr.
	Arkansas sand	Wichita area, Kans.
	Boone sand	Viroqua area, Wis.
Miami sandy loam	Fargo fine sandy loam	Grand Forks area, N. Dak
	Wabash fine sandy loam	Posey County, Ind.
	Coloma sandy loam	Cass County, Mich.
		Munising area, Mich.
		Oxford area, Mich.
		Pontiac area, Mich.
		Carlton area, Minn.
		Portage County, Wis.
		Superior area, Wis.
	Dunkirk sandy loam	Toledo area, Ohio.
		Wooster area, Ohio.
	Knox sandy loam	Dubuque area, Iowa.
	Wabash sandy loam	Montgomery County, Ohio.
	Chenango sandy loam	Marion County, Ind.
	Boone sandy loam	Viroqua area, Wis.
Miami silt loam	Merrimac silt loam	Rhode Island.
	Dunkirk silt loam	Syracuse area, N. Y.
	Knox silt loam	Knox County, Ill.
		McLean County, Ill.
		O'Fallon area, Mo.
		Sangamon County, Ill.
		Winnebago County, Ill.
		Boonville area, Ind.
		Greene County, Ind.
		Posey County, Ind.
		Tippecanoe County, Ind.
		Tama County, Iowa.
		Union County, Ky.
		Dubuque area, Iowa.
		Saline County, Mo.
		Sarpy County, Nebr.
		Viroqua area, Wis.
	Marshall silt loam	Clinton County, Ill.
		St. Clair County, Ill.
Miami stony loam	Cazenovia loam	Madison County, N. Y.
		Syracuse area, N. Y.
	Flushing loam	Long Island area, N. Y.
		Rhode Island.
	Miami loam	Cass County, Mich.
		Carlton area, Minn.
		Cleveland area, Ohio.
		Wooster area, Ohio.
		Portage County, Wis.
	Ontario loam	Auburn area, N. Y.
		Lyons area, N. Y.
		Tompkins County, N. Y.
Miami stony sand	Coloma stony sand	Portage County, Wis.
Miller heavy clay	Miller clay	Waco area, Tex.
Moccasin stony clay	Hagerstown stony clay	Grainger County, Tenn.
Monroe fine sandy loam	Miller fine sandy loam	Ouachita Parish, La.
Monterey sandy loam	Sites sandy loam	Pajaro area, Cal.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Muck	Meadow	Baker City area, Oreg.
Murrill sandy loam	Hagerstown sandy loam	Bedford area, Va.
Murrill stony loam	Hagerstown stony loam	Do.
Myrtle clay	Melbourne clay	Marshfield area, Oreg.
Nellis loam	Farmington loam	Montgomery County, N. Y.
Neuse clay	Congaree clay	McNeill area, Miss.
		Craven area, N. C.
		Raleigh to Newbern, N. C.
Newman stony loam	Hagerstown stony loam	Grainger County, Tenn.
Norfolk clay	Cahaba clay	Dallas County, Ala.
		Montgomery County, Ala.
Norfolk coarse sand	Merrimac coarse sand	Long Island area, N. Y.
		Rhode Island.
Norfolk coarse sandy loam	Merrimac coarse sandy loam	Long Island area, N. Y.
		Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Norfolk fine sandy loam	Cumberland fine sandy loam	Mason County, Ky.
Norfolk gravel	Susquehanna gravel	Long Island area, N. Y.
Norfolk loam	Cumberland sandy loam	Mason County, Ky.
	Huntington fine sandy loam	Lock Haven area, Pa.
	Kalmia loam	Lamar County, Ala.
		Prentiss County, Miss.
	Sassafras fine sandy loam	Prince George County, Md.
		St. Mary County, Md.
	Sassafras loam	Calvert County, Md.
	Sassafras sandy loam	Dover area, Del.
		Norfolk area, Va.
Norfolk sand	Norfolk fine sand	Craven area, N. C.
		Raleigh to Newbern, N. C.
		Norfolk area, Va.
		Perry County, Ala.
	Sassafras sand	Cecil County, Md.
		Harford County, Md.
		Kent County, Md.
		St. Mary County, Md.
		Salem area, N. J.
		Long Island area, N. Y.
Norfolk sandy loam	Norfolk fine sandy loam	Fort Valley area, Ga.
	Tifton sandy loam	Dodge County, Ga.
Norfolk sandy soil	Norfolk sandy loam	Raleigh to Newbern, N. C.
		Darlington area, S. C.
Norfolk silt loam	Crockett loam	San Antonio area, Tex.
	Huntington loam	Lock Haven area, Pa.
	Kalmia silt loam	Marion County, Ala.
	Norfolk loam	Chowan County, N. C.
	Sassafras silt loam	Dover area, Del.
		Chester County, Pa.
North Platte loam	Cheyenne loam	North Platte area, Nebr.
Oakdale coarse sandy loam	Sacramento coarse sandy loam	Modesto-Turlock area, Cal.
Oakdale sand	Sacramento sand	Do.
Oakdale sandy loam	Sacramento sandy loam	Do.
Oakland sandy loam	Miami fine sandy loam	Pontiac area, Mich.
Ocklocknee clay	Huntington clay	Macon County, Ala.
Oktibbeha silt loam	Pheba silt loam	Oktibbeha County, Miss.
Olympic loams	Olympic loam	Puget Sound Basin, western part, Wash.
Orangeburg clay	Greenville fine sandy loam	Fort Valley area, Ga.
	Greenville clay loam	Autauga County, Ala.
		Butler County, Ala.
		Dallas County, Ala.
		Macon County, Ala.
		Sumter County, Ala.
		Jasper County, Miss.
		Monroe County, Miss.
		Oktibbeha County, Miss.
		Pontotoc County, Miss.
		Sumter County, S. C.
		Anderson County, Tex.
		Houston area, Tex.
		Lee County, Tex.
		Jacksonville area, Tex.
		Nacogdoches area, Tex.
		Paris area, Tex.
		San Antonio area, Tex.
	Orangeburg fine sandy loam	Perry County, Ala.
Orangeburg fine sand	do	Coffee County, Ala.
		Pike County, Ala.
		Grady County, Ga.
		Thomas County, Ga.
		Caddo Parish, La.
		Jasper County, Miss.
		Lauderdale County, Miss.
		Henderson County, Tex.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Orangeburg loam	Greenville loam	Escambia County, Fla.
		Jasper County, Miss.
	Orangeburg sandy loam	Darlington area, S. C.
Orangeburg sand	do	Autauga County, Ala.
		Butler County, Ala.
		Coffee County, Ala.
		Dale County, Ala.
		Leon County, Fla.
		Bainbridge area, Ga.
		Sumter County, Ga.
		Lauderdale County, Miss.
		Orangeburg County, S. C.
		Sumter County, S. C.
		Franklin County, Tex.
		Robertson County, Tex.
Orangeburg sandy loam	Orangeburg fine sandy loam	Perry County, Ala.
		Gadsden County, Fla.
		Fort Valley area, Ga.
Orangeburg silt loam	Miller silt loam	Paris area, Tex.
Orland fine sand	Elder fine sand	Colusa area, Cal.
Orland fine sandy loam	Yolo fine sandy loam	Do.
Oswego loam	Oswego silt loam	Parsons area, Kans.
Oswego silt loam	Neosho silt loam	Do.
Oxnard loam	Oxnard clay loam	Los Angeles area, Cal.
		Ventura area, Cal.
		San Jose area, Cal.
Oxnard silt loam	Hanford clay loam	Bakersfield area, Cal.
	Livermore silt loam	San Jose area, Cal.
Pajaro light silt loam	Pajaro fine sandy loam	Pajaro area, Cal.
Pajaro silt clay	Pajaro silty clay	Do.
Pecos conglomerate	Conglomerate	Pecos Valley area, N. Mex.
Pecos gypsum	Gypsum	Do.
Pecos sand	Gila fine sand	Salt River Valley, Ariz.
		Pecos Valley area, N. Mex.
	Gila fine sandy loam	Solomonsville area, Ariz.
Pecos sandy loam	Roswell sandy loam	Pecos Valley area, N. Mex.
Penn clay	Upshur clay	Syracuse area, N. Y.
Penn sandy loam	Upshur sandy loam	Fort Payne area, Ala.
Pilot gravelly loam	Talladega gravelly loam	Montgomery County, Va.
Pilot loam	Talladega loam	Oconee County, S. C.
		Montgomery County, Va.
Placentia coarse sandy loam	Placentia sandy loam	San Bernardino area, Cal.
Placentia loam	Placentia clay loam	Do.
Placentia sandy loam	Placentia loam	Ventura area, Cal.
	Placentia fine sandy loam	Los Angeles area, Cal.
		Lower Salinas Valley, Cal.
		San Bernardino area, Cal.
		San Gabriel area, Cal.
		San Jose area, Cal.
		Santa Ana area, Cal.
Plainwell stony loam	Coloma stony sand	Allegan County, Mich.
		Pontiac area, Mich.
	Plymouth stony sand	Long Island area, N. Y.
Pocoson	Swamp	Raleigh to Newbern, N. C.
Podunk fine sandy loam	Hartford very fine sandy loam	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Porters red clay	Porters clay	Bedford area, Va.
Portersville coarse sandy loam	Sheridan coarse sandy loam	Portersville area, Cal.
Portersville loam	Hanford loam	Portersville area, Cal.
Portsmouth clay	Portsmouth loam	Craven area, N. C.
Portsmouth sandy loam	Victoria fine sandy loam	San Antonio area, Tex.
Portsmouth silt loam	Elkton silt loam	Chester County, Pa.
Protection loam	Richfield loam	Western Kansas Recon.
Quinton sandy loam	Norfolk sandy loam	Salem area, N. J.
		Trenton area, N. J.
Radford loam	Cumberland loam	Montgomery County, Va.
Redfield sandy loam	Redfield fine sandy loam	Sevier Valley area, Utah.
	Albany fine sandy loam	Laramie area, Wyo.
Rhinebeck loam	Hudson silt loam	Dutchess County, N. Y.
Rio Grande loam	Alamosa clay loam	San Luis Valley, Colo.
Rio Grande sandy loam	Alamosa sandy loam	Do.
Riverton clay loam	Altamont clay loam	Marshfield area, Oreg.
Roswell sandy loam	Roswell fine sandy loam	Pecos Valley, N. Mex.
Russell sandy loam	Oswego sandy loam	Western Kansas Recon
Sacramento clay loam	Sacramento clay	Stockton area, Cal.
Sacramento fine sand	Columbia fine sand	Marysville area, Cal.
		Woodland area, Cal.
		Red Bluff area, Cal.
Sacramento fine sandy loam	Columbia fine sandy loam	Colusa area, Cal.
		Redding area, Cal.
		Red Bluff area, Cal.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Sacramento gravelly sandy loam.	Yolo gravelly sandy loam	Colusa area, Cal.
	Bear gravelly sandy loam	Redding area, Cal.
Sacramento heavy clay	Sacramento clay	Woodland area, Cal.
Sacramento loam	Yolo loam	Colusa area, Cal.
Saginaw sandy loam	Clyde sandy loam	Owosso area, Mich.
		Saginaw area, Mich.
Salem clay	Aiken clay	Salem area, Oreg.
Salem loam	Salem silt loam	Do.
Salem sandy loam	Salem fine sandy loam	Do.
Salinas gray adobe	Maricopa clay loam adobe	San Bernardino area, Cal.
		San Jose area, Cal.
	Salinas clay loam adobe	Lower Salinas Valley, Cal.
	Alamo clay adobe	Sacramento area, Cal.
Salinas shale loam	Oxnard gravelly loam	Lower Salinas Valley, Cal.
		Ventura area, Cal.
Salsipuedes loam	Corralitos loam	Pajaro area, Cal.
Salt Lake sand	Oolitic sand	Salt Lake area, Utah.
		Provo area, Utah.
Salt River adobe	Gila clay	Salt River Valley, Ariz.
		Yuma area. Ariz.
Salt River gravel	Rough stony land	Salt River Valley, Ariz.
San Antonio clay loam	San Antonio silty clay loam	San Antonio area, Tex.
San Gabriel gravelly loam	Maricopa gravelly loam	Ventura area, Cal.
		San Gabriel area, Cal.
San Gabriel gravelly sand	Maricopa gravelly sand	San Gabriel area, Cal.
San Gabriel sandy loam	Maricopa sandy loam	San Bernardino area, Cal.
San Jacinto clay	Houston black clay	Willis area, Tex.
San Joaquin black adobe	Oxnard clay loam adobe	Los Angeles area, Cal.
		San Bernardino area, Cal.
		San Gabriel area, Cal.
		Ventura area, Cal.
	Wade clay	Lower Arkansas Valley, Colo.
	Maricopa clay loam adobe	Fresno area, Cal.
		Hanford area, Cal.
		Santa Ana area, Cal.
	Redwood clay adobe	San Jose area, Cal.
	Salinas clay adobe	Lower Salinas Valley, Cal.
San Joaquin fine sandy loam	Corning fine sandy loam	Colusa area, Cal.
San Joaquin gravelly loam	Corning gravelly loam	Do.
San Joaquin loam	San Joaquin clay loam	Portersville area, Cal.
	Corning loam	Colusa area, Cal.
San Joaquin red adobe	San Joaquin sandy loam adobe	Fresno area, Cal.
	San Joaquin clay adobe	Sacramento area, Cal.
Santa Cruz loam	Melbourne loam	Pajaro area, Cal.
Santa Cruz sand	Sites fine sand	Do.
Santa Cruz sandy loam	Sites sandy loam	Do.
Santiago loam	Placentia loam	Santa Ana area, Cal.
Santiago sandy loam	Placentia fine sandy loam	Do.
Santiago silt loam	Hanford clay loam	San Bernardino area, Cal.
		Lower Salinas Valley, Cal.
	Hanford silt loam	San Gabriel area, Cal.
		Los Angeles area, Cal.
		Santa Ana area, Cal.
	Laurel loam	Lower Arkansas Valley, Colo.
Sassafras loam	Cahaba fine sandy loam	Darlington area, S. C.
	Sassafras silt loam	Calvert County, Md.
		Cecil County, Md.
		Harford County, Md.
		Kent County, Md.
		Prince Georges County, Md.
		St. Mary County, Md.
		Salem area, N. J.
		Trenton area, N. J.
Sassafras sandy loam	Cahaba sandy loam	Perry County, Ala.
	Sassafras fine sandy loam	Calvert County, Md.
	Sassafras loam	Long Island area, N. Y.
Savanna	Swamp	Raleigh to Newbern, N. C.
Scoria gravel	Rough broken land	McKenzie area, N. Dak.
Sedgwick black clay loam	Sedwick clay loam	Wichita area, Kans.
		Bates County, Mo.
Sedgwick clay loam	Oswego silt loam	Russell area, Kans.
	Crawford silt loam	Allen County, Kans.
		Wichita area, Kans.
Sedgwick gravelly loam	Crawford gravelly loam	Allen County, Kans.
Sedgwick loam	Pratt loam	Wichita area, Kans.
Sedgwick sandy loam	Oswego sandy loam	Russell area, Kans.
	Pratt sandy loam	Wichita area, Kans.
Selma clay	Cahaba clay	Fort Valley area, Ga.
		Craven area, N. C.
Selma heavy silt loam	Portsmouth fine sandy loam	Raleigh to Newbern, N. C.
	Portsmouth sandy loam	Darlington area, S. C.
Selma silt loam	Norfolk sandy loam	Raleigh to Newbern, N. C.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Sharkey clay	Miller clay	Miller County, Ark.
	Wabash clay	Allen County, Kans.
		Parsons area, Kans.
	Waverly clay	Union County, Ky.
	Trinity clay	Brazoria area, Tex.
Shelby clay	Shelby loam	Shelby County, Mo.
Shelby sand	Mankato sand	Do.
Shelby silt loam	Putnam silt loam	Scotland County, Mo.
		Shelby County, Mo.
		Putnam County, Mo.
Sierra adobe	Placentia clay loam adobe	Los Angeles area, Cal.
	Sierra sandy loam adobe	Fresno area, Cal.
Sierra clay loam	Auburn clay loam	Sacramento area, Cal.
Sierra loam	Sierra loam adobe	Do.
	Auburn loam	Marysville area, Cal.
Sierra sandy loam	Sierra coarse sandy loam	Sacramento area, Cal.
Sierra stony loam	Arnold stony loam	Do.
Sioux gravelly sandy loam	Fargo gravelly sandy loam	Crookston area, Minn.
Sioux sandy loam	Dunkirk sandy loam	Racine County, Wis.
	Plainfield sandy loam	Winnebago County, Ill.
Sites clay adobe	Diablo clay adobe	Woodland area, Cal.
Sites clay loam adobe	Diablo clay loam adobe	Do.
		Colusa area, Cal.
Sites gravelly sandy loam	Sites gravelly fine sandy loam	Woodland area, Cal.
Sites loam	Diablo loam	Colusa area, Cal.
	Arbuckle loam	Woodland area, Cal.
Sites sandy loam	Sites fine sandy loam	Colusa area, Cal.
Sites silt loam	Arbuckle silt loam	Woodland area, Cal.
Snake River sand	Yakima fine sand	Boise area, Idaho.
Soledad gravelly sand	Maricopa gravelly sand	Lower Salinas Valley, Cal.
Stockton loam	Yolo loam	Modesto-Turlock area, Cal.
		Stockton area, Cal.
Sturgis fine sandy loam	Lintonia fine sandy loam	Union County, Ky.
Sunnyside sand	Quincy fine sand	Yakima area, Wash.
Superior gravelly loam	Kewaunee gravelly loam	Fond du Lac County, Wis.
Susquehanna gravel	Norfolk gravel	Calvert County, Md.
		Kent County, Md.
		Prince Georges County, Md.
		St. Mary County, Md.
		Trenton area, N. J.
		Raleigh to Newbern, N. C.
Tazewell silt loam	Knox silt loam	Tazewell County, Ill.
Triassic stony loam	Wethersfield loam	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
Upshur loam	Decatur loam	Blount County, Ala.
Vallecitos clay adobe	Daulton clay adobe	Livermore area, Cal.
Vallecitos loam	Daulton loam	Do.
Vallecitos stony clay loam	Daulton stony clay loam	Do.
Vernon fine sand	Miller fine sand	Paris area, Tex.
Vernon loam	Vernon silt loam	Vernon area, Tex.
Vernon silt loam	Miller silt loam	Do.
Volusia sandy loam	Volusia loam	Westfield area, N. Y.
Wabash clay	Huntington clay	Jefferson County, Ala.
		Conway County, Ark.
	Trinity clay	Oktibbeha County, Miss.
		Bastrop County, Tex.
		Cooper area, Tex.
		Franklin County, Tex.
		Houston County, Tex.
		Robertson County, Tex.
		San Marcos area, Tex.
		Wilson County, Tex.
Wabash clay loam	Huntington clay loam	Fayetteville area, Ark.
Wabash fine sand	Huntington fine sand	Conway County, Ark.
Wabash fine sandy loam	Huntington fine sandy loam	Do.
Wabash loam	Genesee loam	Binghamton, N. Y.
		Tompkins County, N. Y.
	Huntington loam	Fayetteville area, Ark.
Wabash silt clay	Wabash silty clay	Oklahoma County, Okla.
		Riley County, Kans.
Wabash silt loam	Huntington silt loam	Fayetteville area, Ark.
		Conway County, Ark.
		Madison County, Ky.
Waldo loam	Wabash silt loam	Russell area, Kans.
Walla Walla loam	Walla Walla silt loam	Walla Walla area, Wash.
Warren shale loam	Volusia shale loam	Livingston County, N. Y.
Warsaw sandy loam	Cahaba fine sandy loam	Sumter County, Ala.
Warwick sandy loam	Merrimac coarse sandy loam	Rhode Island.
Watsonville clay loam adobe	Melbourne clay loam adobe	Pajaro area, Cal.
Watsonville loam	Altamont clay loam	Do.
Watsonville sandy loam	Melbourne fine sandy loam	Do.
Waverly clay	Bibb clay	Oktibbeha County, Miss.

Alphabetical list of soils changed in correlation, with the new name and the area in which the soil was first encountered—Continued.

Name as published.	Changed to—	Name of area.
Waverly loam	Bibb loam	Lamar County, Ala.
		Oktibbeha County, Miss.
	Ocklocknee loam	Sumter County, Ala.
Waverly silt loam	Bibb silt loam	Bibb County, Ala.
	Wabash silt loam	Posey County, Ind.
		Union County, Ky.
Webb loam	Duval loam	Wilson County, Tex.
Westphalia sand	Norfolk fine sand	Trenton area, N. J.
	Sassafras fine sand	Prince George County, Md.
	Sassafras sand	Salem area, N. J.
Wheatland sand	Fargo sand	Fargo area, N. Dak.
Wheatland sandy loam	Carrington sandy loam	Do.
Willis sand	Norfolk fine sandy loam	Willis area, Tex.
Windsor sand	Merrimac coarse sand	Connecticut Valley, Conn.
		Connecticut Valley, Mass.
	Norfolk coarse sand	Calvert County, Md.
		Prince Georges County, Md.
		St. Mary County, Md.
		Salem area, N. J.
		Trenton area, N. J.
Winnebago sandy loam	Carrington sandy loam	Winnebago County Ill.
Yakima clay adobe	Ewauna clay adobe	Klamath Reclamation Project area, Oreg.
Yakima clay loam	Link clay loam	Do.
Yakima fine sand	Caldwell fine sandy loam	Lewiston area, Idaho.
Yakima fine sandy loam	Baker fine sandy loam	Klamath Reclamation Project area, Oreg.
	Walla Walla silt loam	Lewiston area, Idaho.
		Walla Walla area, Wash.
Yakima gravelly loam	Caldwell gravelly loam	Do
Yakima loam	Langel loam	Klamath Reclamation Project area, Oreg.
	Caldwell loam	Walla Walla area, Wash.
		Blackfoot area, Idaho.
		Baker City area, Oreg.
Yakima sand	Quincy sand	Minidoka area, Idaho.
		Klamath Reclamation Project area, Oreg.
	Winchester sand	Blackfoot area, Idaho.
Yakima sandy loam	Yakima fine sandy loam	Yakima area, Wash.
	Quincy sandy loam	Minidoka area, Idaho.
	Langel fine sandy loam	Klamath Reclamation Project area, Oreg.
	Baker loam	Baker City area, Oreg.
	Moscow loam	Lewiston area, Idaho.
	Walla Walla silt loam	Walla Walla area, Wash.
Yakima silt loam	Caldwell silt loam	Lewiston area, Idaho.
	Manhattan silt loam	Gallatin Valley area, Mont.
Yakima stony clay	Rough stony land	Austin area, Tex.
Yakima stony loam	Quincy fine sandy loam	Yakima area, Wash.
Yazoo clay	Miller clay	Brazoria area, Tex.
	Trinity clay	Waco area, Tex.
		Montgomery County, Ala.
		Anderson County, Tex.
		Austin area, Tex.
	Wabash clay	Clinton County, Ill.
		Johnson County, Ill.
		O'Fallon area, Mo.
		St. Clair County, Ill.
		Tazewell County, Ill.
		Allen County, Kans.
		East Baton Rouge Parish, La.
		Saline County, Mo.
		Wooster area, Ohio.
	Waverly clay	Posey County, Ind.
		Union County, Ky.
	Crawford clay	Parsons area, Kans.
	Sarpy clay	Concordia Parish, La.
	Sharkey clay	Tangipahoa area, La.
		New Orleans area, La.
		Smedes area, Miss.
		Yazoo area, Miss.
Yazoo coarse sand	Riverwash	East and West Carroll Parishes, La.
Yazoo heavy clay	Trinity clay	Waco area, Tex.
Yazoo loam	Waverly loam	Posey County, Ind.
	Trinity loam	Houston County, Tex.
Yazoo sandy loam	Waverly fine sandy loam	Clay county, Ill.
	Trinity fine sandy loam	Anderson County, Tex.
	Trinity sandy loam	Houston County, Tex.
	Pledger silt loam	Brazoria area, Tex.
	Bastrop fine sandy loam	Austin area, Tex.
Yazoo silt loam	Wabash silt loam	Brown County, Kans.

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